PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-112557
(43)Date of publication of application : 28.04.1998

(51)Int.Cl. H01L 33/00
C09K 11/64
G09F 9/33

(21)Application number : 08-266450
(22)Date of filing : 08.10.1996

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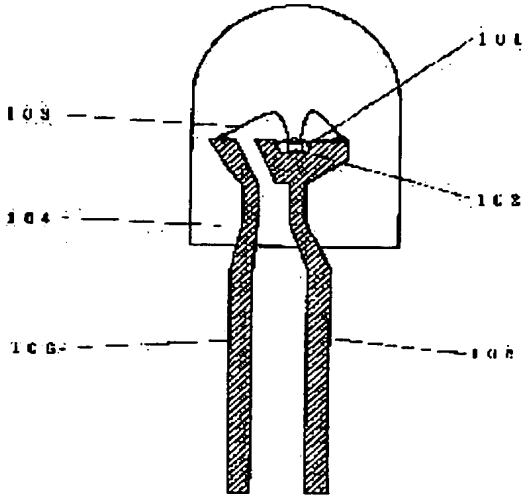
(54) LIGHT EMITTER AND DISPLAY DEVICE USING IT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a light emitter, which has fluorescent matter for converting at least a part of the light emitted from an LED chip and emitting light and has high brightness, high efficiency, and afterglow without depending on use environment, and a display device using it.
SOLUTION: This light emitter has an LED chip 102 where the light emitting layer is a gallium nitride compound semiconductor, and fluorescent matter which absorbs at least a part of the light emitted from this LED chip 102 and converts the wavelength and emits light. In this case, this is a light emitter where the main peak of the light emission of the above LED chip 102 ranges from 360nm to 530nm, and also the above fluorescent matter is activated by bivalent europium and the chemical composition formula is (M1-p-qEupQq)O.n(Al1-nBn)2O3. But, M in the composition formula is bivalent metal and Q is an activator.



LEGAL STATUS

[Date of request for examination]	15.01.2001
[Date of sending the examiner's decision of rejection]	25.10.2002
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	withdrawal
[Date of final disposal for application]	10.12.2002
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The luminescence equipment with which said fluorescent material is activated with divalent europium, and a chemical-composition type is characterized by to be O-n (M1-p-qEupQq) (aluminum1-mBm) 2O3 while a luminous layer is luminescence equipment which has the LED chip which is a gallium-nitride system compound semiconductor, and the fluorescent material which absorbs a part of luminescence [at least] from this LED chip, carries out wavelength conversion and emits light and the main luminescence peak of said LED chip is in 360nm to 530nm.
however -- M in 0.0001<=p<=0.5, 0.0001<=q<=0.5, 0.5<=n<=10, 0<=m<=0.5, 0.0002 <=p+q<=0.75, and an empirical formula -- Mg -- It is at least one sort chosen from the group of the divalent metal which consists of calcium, Sr, Ba, and Zn, and Q is co-activating agent and is at least one sort chosen from the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu.
[Claim 2] The inner lead electrically connected to the LED chip arranged in the cup of a mounting lead, and this LED chip using the conductive wire, The coating member with which you made it filled up in said cup, and the mold member which covers a part of this coating member, an LED chip, conductive wire and mounting lead, and inner lead [at least], It is the light emitting diode which **** and said LED chip is a gallium nitride system compound semiconductor. And light emitting diode characterized by being translucency resin which said coating member is activated with divalent europium, and contains the fluorescent material whose chemical composition type is O-n (M1-p-qEupQq) (aluminum1-mBm) 2O3.
however -- M in 0.0001<=p<=0.5, 0.0001<=q<=0.5, 0.5<=n<=10, 0<=m<=0.5, 0.0002 <=p+q<=0.75, and an empirical formula -- Mg -- It is at least one sort chosen from the group of the divalent metal which consists of calcium, Sr, Ba, and Zn, and Q is co-activating agent and is at least one sort chosen from the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu.
[Claim 3] The display which has the drive circuit which connected luminescence equipment according to claim 1 to the drop arranged two or more and this drop electrically.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] The invention in this application has the fluorescent material which a part of luminescence [at least] from the LED chip which is especially a light emitting device is changed [fluorescent material], and makes it emit light with respect to the luminescence equipment used for the back light light source, an LED indicator, an illumination type switch, various indicators, etc., and does not twist it to an operating environment, but relates to high brightness, and efficient, the luminescence equipment which has afterglow nature and the display using it.
[0002]
[Description of the Prior Art] Various displays are prepared today with development of portable electronic devices, such as a transceiver, a camera, a pocket bell, portable radio, a videocassette recorder, and a notebook sized personal computer, for operability or the improvement in visibility. There are some which used liquid crystal equipment for one of the display of this, and the back light is provided so that it can be used also in a dark place. Since there is a merit, like a time etc. increases, emitting light especially in a low power and high brightness is called for, so that it will carry out, if, as for the back light for portable electronic devices, such a back light reduces the power consumption. The thing which makes the light source from an LED chip emit light in high brightness by making light emit in the shape of a field etc. is in such one of the back light light sources. An LED chip is small and carries out luminescence of a color efficient and skillful in it. Moreover, since it is a semiconductor device, there are no worries about a ball piece etc. An initial drive property is excellent and it can consider as the back light light source using the description that it is strong to the repeat of vibration or ON/OFF lighting etc.
[0003] On the other hand, a duty of installation of a guide light is imposed upon locations in which there are many people and it gathers, such as a theater and a hotel, for the fire prevention regulations of the Fire Service Law enforcement ordinance and national each city etc. When a power source in ordinary use is severed by disaster, such as an earthquake and a fire, and other catastrophic failures, it changes to a standby power source automatically, and lighting for 20 minutes or more is needed. It can also consider as the drop which employed efficiently the property of the LED chip which is a high brightness low power also in such a guide light.
[0004] However, the back light made to form using an LED chip is a semi-conductor light emitting device, and although it is a low power, it consumes cell power. Therefore, it may become a big load in order to make it drive for a long time, when there are few amounts of accumulation of electricity of a cell power source. Moreover, the light may be put out, if the standby power source of a drop is destroyed at the time of disaster or a feeder circuit carries out a broken line etc. Therefore, when the case where there is little power, a feeder circuit, etc. stop, the drop which can display sufficient brightness is called for.
[0005]
[Problem(s) to be Solved by the Invention] The display which has light emitting diode and the fluorescent material excited by it as a display in alignment with such a request can be considered.
[0006] However, an LED chip has some which have various luminescence wavelength according to a presentation, structure, etc. of a semi-conductor. Similarly, various things, such as that to which the fluorescent material excited with an LED chip also has organic, an inorganic compound, and afterglow nature in fluorescent dye and a fluorescent pigment pan, are mentioned.
[0007] Moreover, when it approaches around an LED chip and arranges a fluorescent material, it is exposed to the beam of light of 40 times and the strong exposure reinforcement which reaches also more than it depending on the case from about 30 times rather than sunlight. When the amount of the improvement in conversion efficiency of a fluorescent material or the fluorescent material used is reduced using the semi-conductor which has a high energy band gap for the LED chip which is a light emitting device especially, even if it says that a light region has the main luminescence which emitted light from the LED chip, light energy becomes high inevitably. Moreover, if light may be emitted in an ultraviolet-rays field, luminescence reinforcement is raised further and it is used over a long period of time, the fluorescent material itself will tend to deteriorate. The fluorescent material similarly prepared near the LED chip is exposed also to elevated temperatures, such as heating from the temperature up and external environment of an LED chip. Furthermore, although the light emitting diode which is one sort of luminescence equipment is generally covered by resin mold, it cannot remove completely the moisture which adhered at the time of preventing penetration of the moisture from an external environment etc. completely, or manufacture. Depending on a fluorescent material, such moisture may promote degradation of a fluorescent material with the high energy light and the heat from a light emitting device. Moreover, when a fluorescent material deteriorates, there are that to which a fluorescent material becomes blackish and the external ejection effectiveness of light falls, and a remarkable case where afterglow nature becomes short. Furthermore, also when stopping showing afterglow nature, it is. Therefore, the invention in this application solves the above-mentioned technical problem, and it aims at offering the luminescence equipment with which decline in luminescence **** has afterglow nature very few under high brightness and the operating environment of long duration more.
[0008]
[Means for Solving the Problem] A luminous layer is luminescence equipment which has the LED chip which is a gallium nitride system compound semiconductor, and the fluorescent material which absorbs a part of luminescence [at least] from this LED chip, carries out wavelength conversion and emits light, said fluorescent material is activated with divalent europium, and the invention in this application is luminescence equipment whose chemical composition type is O-n (M1-p-qEupQq) (aluminum1-mBm) 2O3 while the main luminescence peak of said LED chip is in 360nm to 530nm. however, M in $0.0001 \leq p \leq 0.5$, $0.0001 \leq q \leq 0.5$, $0.5 \leq n \leq 10$, $0 \leq m \leq 0.5$,

0.0002 <=p+q<=0.75, and an empirical formula -- Mg -- it is at least one sort chosen from the group of the divalent metal which consists of calcium, Sr, Ba, and Zn, and Q is co-activating agent and is at least one sort chosen from the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu.

[0009] Moreover, the inner lead electrically connected to the LED chip arranged in the cup of a mounting lead, and this LED chip using the conductive wire, The coating member with which you made it filled up in said cup, and the mold member which covers a part of this coating member, an LED chip, conductive wire and mounting lead, and inner lead [at least], It is the light emitting diode which **** and said LED chip is a gallium nitride system compound semiconductor. And it is the light emitting diode which is translucency resin which said coating member is activated with divalent europium, and contains the fluorescent material whose chemical composition type is O-n (M1-p-qEupQq) (aluminum1-mBm) 2O3. however, M in 0.0001<=p<=0.5, 0.0001<=q<=0.5, 0.5<=n<=10, 0<=m<=0.5, 0.0002 <=p+q<=0.75, and an empirical formula -- Mg -- it is at least one sort chosen from the group of the divalent metal which consists of calcium, Sr, Ba, and Zn, and Q is co-activating agent and is at least one sort chosen from the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu.

[0010] Furthermore, it is the display which has the drive circuit which connected above-mentioned luminescence equipment to the drop arranged or more to two, and this drop electrically.

[0011]

[Embodiment of the Invention] As a result of various experiments, an invention-in-this-application person came to accomplish the header invention in this application for the ability of the fall of high brightness and the optical effectiveness at the time of use of long duration, or afterglow nature to be prevented, when light energy chooses a specific semi-conductor and a specific fluorescent material in the luminescence equipment which carries out wavelength conversion of a part of luminescence [at least] from a comparatively high LED chip with a fluorescent material.

[0012] That is, to excel in 1. lightfastness is demanded as a fluorescent material used for luminescence equipment. Since it strong- emanates from minute fields, such as a semi-conductor light emitting device, especially, it needs to be equal also to the strong exposure which reaches also 40 times from about 30 times of sunlight enough. 2. Since it is arranged near the light emitting device, the temperature characteristic be good. 3. Having the descriptions, like afterglow nature does not fall with the light of being [weatherability]-according to use environment of luminescence equipment 4. luminescence equipment, heat, etc. is called for.

[0013] The invention in this application uses O-n (aluminum1-mBm) 2O3 for the luminous layer of a light emitting device for the gallium nitride system compound semiconductor element which has a high energy band gap as a fluorescent material (M1-p-qEupQq) as what fulfills these conditions. Even if it is the case where the high energy light in the light region emitted from the light emitting device by this is irradiated near the long duration at high brightness, the fall of luminescence brightness or afterglow nature can consider as very little luminescence equipment.

[0014] As an example of concrete luminescence equipment, the chip type LED is shown in drawing 2 . The LED chip 202 which used the gallium nitride system semi-conductor is made to have fixed using an epoxy resin etc. in the chip type LED case 204. The gold streak is electrically connected to each electrode of the LED chip 202, and each electrode 205 in which it was prepared by the case as a conductive wire 203, respectively. (Sr0.952Eu0.03Dy0.015Tm0.003) Homogeneity is made to carry out hardening formation of what carried out mixed distribution of the O-(aluminum 0.988B0.012) 2O3 fluorescent material into the epoxy resin as a mold member 201 which protects an LED chip, a conductive wire, etc. from external force etc. The LED chip 202 is made to emit light by making such luminescence equipment supply power. The color mixture light of luminescence from the LED chip 202 and luminescence from the fluorescent material excited by the luminescence emits light. In after switching off an LED chip, it can consider as the luminescence equipment which can emit light only by the afterglow from a fluorescent material. Hereafter, the configuration member of the invention in this application is explained in full detail.

[0015] (Fluorescent material) The fluorescent material which is excited as a fluorescent material used for the invention in this application by the electromagnetic wave which emitted light from the semi-conductor luminous layer, and emits light is said. As a concrete fluorescent material, it is O-n (M1-p-qEupQq) (aluminum1-mBm) 2O3. Various things are mentioned as a use gestalt. It is good also considering opening which shuts up an LED chip in the bulk layer of a fluorescent material etc., and the light from an LED chip specifically penetrates in a fluorescent material layer as 1 thru/or luminescence equipment of a configuration of having two or more. Moreover, you may make it form in extent which is made to contain the fine particles of a fluorescent material in the resin which covers an LED chip, or glass, and the light from an LED chip penetrates thinly. Furthermore, you may make it mix in the edge strip between the light emitting diodes which arranged two or more light emitting diodes. Various color tones and afterglow nature can be chosen by choosing adjusting various ratios of the particle size of a fluorescent material, a fluorescent material, resin, etc., and spreading and fills, and the luminescence wavelength of a light emitting device.

[0016] Furthermore, content distribution of a fluorescent material influences color mixture nature, endurance, etc. That is, it is easy to control degradation by moisture that it is harder to be influenced of the moisture from an external environment etc. toward an LED chip by the front-faces side, such as the coating section which the fluorescent material contained, and a mold member, when the distribution concentration of a fluorescent material is high. On the other hand, if distribution concentration becomes high toward an LED chip to a mold member front-face side about content distribution of a fluorescent material, although it will be easy to be influenced of the moisture from an external environment, the effect of generation of heat from an LED chip, exposure reinforcement, etc. can control degradation of a fluorescent material fewer. Such distribution of a fluorescent material can be made to form variously by making the member containing a fluorescent material, formation temperature, viscosity, the configuration of a fluorescent material, particle size distribution, etc. adjust. Therefore, various distribution concentration of a fluorescent material can be chosen according to a service condition etc.

[0017] or the fluorescent material used for the invention in this application touched the LED chip, when it approaches and has been arranged, it is enough -- it ********. Moreover, especially when the heat dissipation from an LED chip is large, 1.5 to 3 has desirable n. The activator and co-activating agent which are introduced into the afterglow nature fluorescent material of the invention in this application influence a fluorescence color and afterglow brightness greatly. Therefore, according to an application, it can adjust to the range as shown below, respectively.

[0018] That is, about the concentration p of Eu of an activator, it is desirable to adjust Sr of a parent to the range permuted 0.5 mols or less 0.0001 mols or more to one mol of fluorescent materials. This is because it is in the inclination for afterglow brightness to fall as a result by light absorption worsening when fewer than 0.0001 mols. On the contrary, when it increases more than 0.5 mols, it is in the inclination for lifting afterglow brightness to fall, about concentration quenching. When the range of p is 0.001<=p<=0.06, afterglow

brightness can make it high more.
[0019] Luminescence of Eu comes to show afterglow nature by introducing co-activating agent. it was chosen out of the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu as co-activating agent -- a kind is effective even if not few.
[0020] Especially in the case of Sr, divalent metal M of Dy which is the parent of a fluorescent material is effective on an afterglow disposition, and the density range of the Dy concentration q has 0.0005 or more and 0.03 or less desirable range. Similarly, as for Nd, in the case of calcium, divalent metal M which is the parent of a fluorescent material has effectiveness especially at especially the improvement in afterglow brightness, and the range of the Nd concentration q has 0.0005 or more and 0.03 or less desirable range. The synergistic effect can be demonstrated by 2nd activating other co-activating agent to these co-activating agent Dy and Nd.
[0021] When choosing Dy as the first co-activating agent, the range where the Mn concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and, specifically, 0.0005 or more and 0.02 or less range is still more desirable. Moreover, when choosing Dy as the first co-activating agent, the range where the Tm concentration q of the 2nd co-activating agent is desirable is 0.0003 or more and 0.02 or less, and 0.0004 or more and 0.01 or less range is still more desirable. Similarly, when choosing Dy as the first co-activating agent, the range where the Lu concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0004 or more and 0.04 or less range is still more desirable. When choosing Dy as the first co-activating agent, the range where the Nb concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.08 or less, and 0.0003 or more and 0.04 or less range is still more desirable. When choosing Dy as the first co-activating agent, the range where the Yb concentration q of the 2nd co-activating agent is desirable is 0.0002 or more and 0.04 or less, and 0.0003 or more and 0.01 or less range is still more desirable. When choosing Dy as the first co-activating agent, the range where the Zr concentration q of the 2nd co-activating agent is desirable is 0.002 or more and 0.70 or less. When choosing Dy as the first co-activating agent, the range where the Er concentration q of the second co-activating agent is desirable is 0.0001 or more and 0.03 or less. Furthermore, 0.0005 or more and 0.02 or less range is desirable. When choosing Dy as the first co-activating agent, the range where the Pr concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.04 or less. Furthermore, 0.0005 or more and 0.03 or less range is desirable.
[0022] When introducing Nd as the first co-activating agent, the range where the Tm concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable. When introducing Nd as the first co-activating agent, the range where the Pr concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable. When introducing Nd below as the first co-activating agent, the range where the Ho concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable. When introducing Nd below as the first co-activating agent, the range where the Dy concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable further again.
[0023] About the parent presentation of an afterglow nature fluorescent material, a part of aluminum can also be permuted by boron. In this case, the decay characteristic can also be made to improve still more greatly. Therefore, more preferably, the range which 0.5 mols of boron permute by the fluorescent material used for the invention in this application from 01 mols of the total number of mols of aluminum is desirable, and near 0.05 mol is [it is the range which becomes 0.25 mols from 0.005 mols, and] the most desirable. In order to introduce boron, it is desirable that only the amount corresponding to it deducts and teaches aluminum.
[0024] As for the afterglow nature fluorescent material used for the invention in this application, it is desirable to choose SrO, MgO, aluminum 2O3, a metallic oxide like Eu2O3, or a compound that turns into an oxide easily by calcinating at an elevated temperature like CaCO3, SrCO3, and BaCO3 as a raw material. Other than a carbonate, there are a nitrate, an oxalate, a hydroxide, etc. as such a compound. Moreover, as a boron compound, a boric acid or the borate of an alkaline earth can be used, and a boric acid is desirable especially. The purity of a raw material influences afterglow brightness greatly, it is desirable that it is 99.9% or more, and it is still more desirable that it is 99.99% or more. The raw material which mixed these can be calcinated under reducing atmosphere in 1200-degree-C or more temperature requirement 1600 degrees C or less, and a fluorescent material can be obtained for a burned product by grinding and carrying out a screen. In addition, the mixed ratio of a raw material can be determined by mixing the amount of theory for acquiring the target presentation.
[0025] Although the fluorescent material used for the invention in this application presents strong luminescence by divalent Eu of an activator fundamentally, divalent Eu has absorption in the large area of an ultraviolet area from the light. Therefore, even if it uses a gallium nitride system compound semiconductor, efficient luminescence is fully possible. Moreover, an afterglow phenomenon appears by making the parent of a fluorescent material dope at least one sort chosen from the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu as co-activating agent.
[0026] If boron is made to contain in an afterglow nature fluorescent material, the crystallinity of aluminates can be made good, and afterglow time amount and afterglow brightness can also be made to improve further by stabilizing an emission center and a trapping center. Moreover, boron also has the effectiveness which works as flux to coincidence and promotes the crystal growth of a fluorescent material.
[0027] When the total number of mols of the total number of mols of the oxide of divalent metal, an activator, and co-activating agent, an alumina, and a boric acid is about 1:1, n= 1 [i.e.,], as a result of analyzing according to an X diffraction, the crystal structure serves as monoclinic system of SrAl2O4 mold, and green luminescence which has a peak in the wavelength of 520nm is shown. Moreover, although the low concentration whose permutation of boron is about 1 mol % shows the structure of SrAl 4O7 which should be generated from a preparation presentation when the total number of mols of the total number of mols of the oxide of divalent metal, an activator, and co-activating agent, an alumina, and a boric acid is taught to 1:2, n= 2 [i.e.,], and is calcinated, boron serves as mixture of Sr4aluminum 14O25 and SrAl 12O19 from this by high concentration. That is, by containing boron, the crystal structure can change and afterglow nature can also be raised. Similarly, at the time of n= 1.75, it can be set to Sr4aluminum 14O25, and thermal resistance etc. can also be raised more. As for such a presentation, it is desirable to make it choose in consideration of the purpose of use, the emission spectrum from an LED chip, or the excitation spectrum of a fluorescent material.
[0028] That is, the luminescent color can be changed to blue, a bluish green color, green, and Oshi by adjusting a parent presentation to the specific range. Moreover, by boron content to a parent presentation, stabilization of the crystal structure and particle growth can be promoted and high brightness-ization of afterglow can be attained as the result. Furthermore, when-izing of the afterglow brightness can be carried out [high brightness] further and especially Zr is chosen as the second co-activating agent with the combination of the first co-activating agent and the second co-activating agent, a luminescent color tone can also be changed.
[0029] In the luminescence equipment of the invention in this application, a fluorescent material may mix two or more kinds of 2OO-n

(M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent materials. Two or more kinds of 2OO-n(M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent materials with which the element and content of M or Q differ from each other can be mixed, and a luminescence wavelength component can also be increased. Thereby, it can also consider as the luminescence equipment which can choose the various luminescent color. Moreover, it can consider as the multilayers which resin different, respectively was made to mix, and can also be made to excite by the semi-conductor light emitting device.

[0030] (LED chips 102, 202, 402, and 502) With the LED chip used for the invention in this application, the nitride system compound semiconductor which can excite efficiently 2OO-n(M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent material is mentioned. the LED chip which is a light emitting device -- MOCVD -- nitride system compound semiconductors, such as general formula InaAlbGa1-a-bN (however, 0<=a, 0<=b, a+b<1), are made to form as a luminous layer on a substrate by law etc. As structure of a semi-conductor, the thing of a terrorism configuration is mentioned to the gay structure, hetero structure, or double which has MIS junction, PIN junction, a PN junction, etc. Various luminescence wavelength can be chosen by whenever [ingredient or its mixed-crystal]. [of a semi-conductor layer] Moreover, it can also consider as the single quantum well structure and multiplex quantum well structure where the semi-conductor barrier layer was made to form in the thin film which the quantum effectiveness produces.

[0031] When a gallium nitride system compound semiconductor is used, ingredients, such as sapphire, a spinel, and SiC, Si, ZnO, are used for a semi-conductor substrate. In order to make crystalline good gallium nitride form, it is desirable to use a sapphire substrate. Buffer layers, such as GaN and AlN, are formed on this sapphire substrate, and the gallium nitride system semi-conductor which has a PN junction is made to form on it. A gallium nitride system semi-conductor shows N type conductivity in the condition of not doping an impurity. When making the N type gallium nitride semi-conductor of a request, such as raising luminous efficiency, form, it is desirable to introduce Si, germanium, Se, Te, C, etc. suitably as an N type dopant. On the other hand, when making a P type gallium nitride semi-conductor form, Zn, Mg, Be, calcium, Sr, Ba, etc. which are P type DOPANDO are made to dope. Only by doping a p-type dopant, since itis [P-type-] hard toize a gallium nitride system compound semiconductor, it is desirable to make it P-type-ize by annealing after p-type dopant installation by heating, the low-speed electron beam irradiation, the plasma exposure, etc. at a furnace. After making the exposure of a P-type semiconductor and an N-type semiconductor form by etching etc., the sputtering method, a vacuum deposition method, etc. are used and each electrode of a desired configuration is made to form on a semi-conductor layer.

[0032] Next, after carrying out direct full cutting with the dicing saw with which the blade which has the edge of a blade made from a diamond rotates the formed semi-conductor wafer or cutting the slot of width of face larger than edge-of-a-blade width of face deeply (half cutting), a semi-conductor wafer is broken according to external force. or the scriber in which the diamond stylus at a tip carries out both-way rectilinear motion -- a scribe line (circles of longitude) very thin to a semi-conductor wafer -- for example, after lengthening in a grid pattern, according to external force, a wafer is broken and it cuts in the shape of a chip from a semi-conductor wafer. Thus, the LED chip which is a gallium nitride system compound semiconductor can be made to form.

[0033] In the luminescence equipment of the invention in this application, efficiently, luminescence and when carrying out afterglow, in consideration of excitation wavelength with a fluorescent material etc., the luminescence wavelength of a light emitting device has 360nm or more desirable 530nm or less, and 380nm or more 490nm or less is more desirable. Moreover, in order to raise the property of luminescence equipment more in consideration of degradation of the mold member and coating material which were made to form by resin, or the color mixture of an LED chip and a fluorescent material, 400nm or more 475nm or less is still more desirable. The emission spectrum of the luminescence equipment which has the afterglow nature of the invention in this application is shown in drawing 3 . Luminescence which has a peak near 410nm is luminescence from an LED chip, and luminescence which has a peak near 520nm is luminescence of the fluorescent material excited with an LED chip. In addition, since the luminescence wavelength of less than 400nm includes an ultraviolet-rays region, it will have the monochromaticity of only luminescence from a fluorescent material.

[0034] (Conductive wires 103, 203, and 403) As conductive wires 103, 203, and 403, what has ohmic nature with the electrode of the LED chips 102, 202, and 502, mechanical-connections nature, good electrical conductivity, and good thermal conductivity is called for. As thermal conductivity, more than 0.01 cal/cm2/cm/degree C is desirable, and it is more than 0.5 cal/cm2/cm/degree C more preferably. Moreover, in consideration of workability etc., the diameters of a conductive wire are more than phi10micrometer and less than [phi45micrometer] preferably. Specifically, the conductive wire using metals and those alloys, such as gold, copper, platinum, and aluminum, as such a conductive wire is mentioned. Such a conductive wire can connect an inner lead, a mounting lead, etc. to the electrode of each LED chip easily by the wire-bonding device.

[0035] (Mounting lead 105) As mounting lead 105, the LED chip 102 is arranged and there should just be sufficient magnitude to load by die BONDODA etc. Moreover, when installing two or more LED chips and using a mounting lead as a common electrode of an LED chip, sufficient electrical conductivity and connectability with a bonding wire etc. are called for. Moreover, while arranging an LED chip in the cup on a mounting lead, when making the interior fill up with a fluorescent material, it can prevent carrying out false lighting by the light from another light emitting diode approached and arranged.

[0036] Thermosetting resin etc. can perform adhesion with the LED chip 102 and the cup of the mounting lead 105. Specifically, an epoxy resin, acrylic resin, imide resin, etc. are mentioned. Moreover, while making it paste up with a mounting lead with a face down LED chip etc., in order to make it connect electrically, Ag paste, carbon paste, an ITO paste, a metal bump, etc. can be used. Furthermore, in order to raise the efficiency for light utilization of a light emitting diode, the front face of the mounting lead with which an LED chip is arranged may be made into the shape of a mirror plane, and a reflex function may be given to a front face. As for the surface roughness in this case, less than [more than 0.1S0.8S] is desirable. Moreover, as concrete electric resistance of a mounting lead, below 300micro ohm-cm is desirable, and it is below 3micro ohm-cm more preferably. Moreover, when ****(ing) two or more LED chips on a mounting lead, since the calorific value from an LED chip increases, it is called for that thermal conductivity is good. concrete -- more than 0.01 cal/cm2/cm/degree C -- desirable -- more -- desirable -- It is more than 0.5 cal/cm2/cm/degree C. As an ingredient which fulfills these conditions, a ceramic with iron, copper, the copper containing iron, the copper containing tin, and a metallizing pattern etc. is mentioned.

[0037] (Inner lead 106) Connection with the conductive wire 103 connected with the LED chip 102 arranged on the mounting lead 105 as an inner lead 106 is aimed at. When two or more LED chips are prepared on a mounting lead, it is necessary to consider as the configuration which can be arranged so that each conductive wires may not contact. Specifically, contact of the conductive wire connected to the inner lead which is separated from a mounting lead can be prevented by enlarging area of the end face in which an inner lead carries out wire bonding etc. as it separates from a mounting lead. As for the granularity of a connection end face with a conductive wire, in consideration of adhesion, less than [more than 1.6S10S] is desirable. After making the configuration of a leadframe decide, pierce and form with shuttering beforehand or making all inner leads form, you may make it form by deleting a part of inner lead

upper part, in order to make the point of an inner lead form in various configurations. Furthermore, a desired area and the desired end-face height of an end face can also be made to form in coincidence by piercing an inner lead and pressurizing from an end face after formation.

[0038] It is called for that connectability and electrical conductivity of an inner lead with the bonding wire which is a conductive wire are good. As concrete electric resistance, below 300micro ohm-cm is desirable, and it is below 3micro ohm-cm more preferably. As an ingredient which fulfills these conditions, the aluminum which plated iron, copper, the copper containing iron, the copper containing tin and copper, gold, and silver, iron, copper, etc. are mentioned.

[0039] (Coating sections 101 and 501) The afterglow nature fluorescent material which the mold member 104 is independently formed in the cup of a mounting lead, and changes luminescence of an LED chip contains the coating sections 101 and 501 used for the invention in this application. As a concrete ingredient of the coating section, transparence resin, glass, etc. excellent in weatherability, such as an epoxy resin, a urea resin, and silicone, are used suitably. Moreover, a color pigment, a coloring color, and a dispersing agent may be made to contain with a fluorescent material. A tint can also be made to adjust by using a color pigment and a coloring color. Moreover, an angle of beam spread can also be increased more by making a dispersing agent contain. As a concrete dispersing agent, barium titanate, titanium oxide, an aluminum oxide, oxidation silicon, etc. are used suitably.

[0040] (Mold members 104 and 404) The mold member 104 can be formed in order to protect from the exterior the coating section 101 which the LED chip 102, the conductive wire 103, and the fluorescent material contained according to the use application of a light emitting diode. A mold member can be made to form using glass or resin. Moreover, although an angle of visibility can be increased by making a fluorescent material contain, by making a mold member contain a dispersing agent, the directivity from the LED chip 102 can be made to be able to ease, and an angle of visibility can be increased further. Furthermore, the lens effectiveness which converge luminescence from an LED chip by making the mold member 104 into a desired configuration again, or it is made to diffuse can be given. Therefore, the structure which carried out two or more laminatings is sufficient as the mold member 104. Specifically, what saw from the luminescence observation side side and combined two or more elliptical and them is mentioned to a convex lens configuration and a concave lens configuration pan.

[0041] As a concrete ingredient of the mold member 104, transparence resin, glass, etc. which were mainly excellent in weatherability, such as an epoxy resin, a urea resin, and silicone, are used suitably. Moreover, as a dispersing agent, barium titanate, titanium oxide, an aluminum oxide, oxidation silicon, etc. are used suitably. Furthermore, a fluorescent material can also be made to contain also in a mold member in addition to a dispersing agent. Therefore, even if it makes it contain in a mold member, the other coating section etc. is made to contain a fluorescent material, and it may be used. Moreover, the resin with which the fluorescent material contained the coating section, and a mold member may be made to form using a different member used as glass etc. In this case, it can consider as light emitting diode with at best [productivity] more little effect of moisture etc. Moreover, a mold member and the coating section may be made to form using the same member in consideration of a refractive index.

[0042] (Display) As an example at the time of using the luminescence equipment of the invention in this application for an LED drop, the outline cross-section configuration of the LED drop which arranged luminescence equipment in desired configurations, such as an indicator and an arrow-head configuration, is shown in drawing 4 . Drawing 4 (A) puts in order the luminescence equipment with which the afterglow nature fluorescent material was mixed equally in the luminescence side top mold member of the LED chip 402, and drawing 4 (B) puts in order the luminescence equipment made to form on a coating member as light emitting diode in which the mold member 404 was made to form. Moreover, drawing 4 (C) shows the luminescence equipment which arranged the high-persistence fluorescent material content member 401 only in the direction of a perimeter of the field where the LED chip 402 emits light. It can consider as the display made to connect any luminescence equipment to the same drive circuit.

[0043] An LED drop is electrically connected to the lighting circuit which is a drive circuit. It can consider as the drop which makes a request turn on luminescence equipment by the output pulse from a drive circuit. It is switched with the output signal of the gradation control circuit which calculates the gradation signal for making predetermined brightness turn on each luminescence equipment from the data memorized by RAM (Random, Access, Memory) and RAM which make the data inputted memorize temporarily as a drive circuit, and a gradation control circuit, and has the driver which makes each luminescence equipment turn on. A gradation control circuit calculates the lighting time amount of luminescence equipment from the data memorized by RAM, and outputs it as a pulse signal etc. Here, if drive lighting of the luminescence equipment is carried out, in addition to the luminescent color from luminescence equipment, luminescence of a fluorescent material can also be displayed. Next, if luminescence equipment is made to switch off, it can consider as the drop with which the luminescent color of only the fluorescent material which has afterglow nature is emitting light. A color tone is also changeable by choosing each luminescence wavelength. Therefore, it can consider as the display which attracts attention also in a low power, night, etc.

[0044] (Field-like luminescence light source) Drawing 5 is the example which constituted the field-like luminescence light source using the luminescence equipment of the invention in this application. The dispersion sheet 506 on the coating section or a light guide plate is made to contain a fluorescent material in the case of the field-like luminescence light source. Or it can also consider as the luminescence equipment which was made to carry out spreading etc. to the dispersion sheet 506, formed in the shape of [501] a sheet, and omitted the mold member with binder resin. Specifically, the LED chip 502 is fixed in the metal substrate 503 of the crevice configuration in which the insulating layer and the conductive pattern were formed. After taking an electric flow with an LED chip and the conductive pattern on a substrate, you make it filled up on the substrate 503 into which mixed churning of the fluorescent material was carried out with the epoxy resin, and the LED chip 502 was loaded, and luminescence equipment is made to form. In this way, the formed luminescence equipment is fixed to the end face of the acrylic light guide plate 504 with an epoxy resin etc. On one principal plane of a light guide plate 504, the reflective member 507 of the shape of a film which the white dispersion agent contained for luminescence unevenness prevention is arranged. Similarly the reflective member 505 is formed also on the end face by which the whole rear-face side surface or luminescence equipment of a light guide plate are not arranged, and luminescence **** is raised. It can consider as the field-like luminescence light source which can obtain brightness sufficient as a back light of LCD by this.

[0045] When using as a liquid crystal display, the polarizing plate arranged through the liquid crystal equipment poured in between the glass substrates with which the translucency conductivity pattern was formed on the principal plane of a light guide plate 504 can be made to constitute. Furthermore, when using it as a portable equipment etc., luminescence equipment, liquid crystal equipment, other operation means, etc. are connected to a cell power source. Moreover, it can have a comparison means in comparison with the set point which the value detected while having a detection means to detect the accumulation-of-electricity residue of a cell power source, ROM (Read On Memory), etc. were made to memorize, and a means to stop the power supplied to luminescence equipment when it makes it

judge that it is made to compare and there are few accumulation-of-electricity residues than a request value. Other electrical circuits can be made to drive, making the life of a cell power source prolong by using an LED chip as an astigmatism LGT, or it will reduce the power supplied to an LED chip, if residues, such as a cell power source, become below constant value by this. Moreover, since the solution layer screen changes the luminescent color while being able to emit light efficiently with an afterglow nature fluorescent material, it can also recognize that there are few cell power sources. In this case, as for a fluorescent material, it is desirable to prepare on the shape of a dispersion sheet and the base of a light guide plate.

[0046] When using as a liquid crystal display, since outpatient department light is irradiated by the afterglow nature fluorescent material through a polarizing plate etc., excitation of the light from the outside may be 50% or less. Therefore, depending on outpatient department light, an internal afterglow nature fluorescent material is hard to be excited. Light can be made to shape[of a field]-emit efficiently by making an afterglow nature fluorescent substance emit light by the light emitting device. That is, the invention in this application can be taken as low power and the luminescence equipment which can emit light in high brightness. Although the example of the invention in this application is explained hereafter, it cannot be overemphasized that the invention in this application is not what is limited only to a concrete example.

[0047]

[Example]

(Example 1) The GaInN semi-conductor whose main luminescence peak is 410nm as a light emitting device was used. the sapphire substrate top which made the LED chip wash -- TMG (trimethylgallium) gas, TMI (trimethyl in JUMU) gas, nitrogen gas, and dopant gas -- carrier gas -- a sink and MOCVD -- it was made to form by making a gallium nitride system compound semiconductor form by law The gallium nitride semi-conductor which has N type conductivity, and the gallium nitride semi-conductor which has P type conductivity were formed, and the PN junction was made to form by changing SiH4 and Cp2Mg as dopant gas. (In addition, a buffer layer is made to form on a sapphire substrate, and annealing of the P-type semiconductor has been carried out above 400 degrees C after membrane formation.)

[0048] After exposing PN each semi-conductor front face by etching, each electrode was made to form by the sputtering method, respectively. In this way, after lengthening a scribe line, external force was made to divide the done semi-conductor wafer, and the LED chip was made to form as a light emitting device.

[0049] Die bonding of the LED chip was carried out with the epoxy resin on the mounting lead which has a cup at the tip of the copper leadframe which carried out silver plating. Wire bonding of each electrode of an LED chip, a mounting lead, and the inner lead was carried out by the gold streak, respectively, and the electric flow was taken.

[0050] on the other hand -- a fluorescent material -- as a raw material -- SrCO3 -- 0.015 mols and Dy203 are put into 0.0075 mols, 0.0015 mols and H3BO3 are put [0.988 mols and Eu 2O3] into a 0.024-mol ceramic pot for Tm203, 0.952 mols and aluminum 2O3 are fully mixed with a ball mill, and a mixed raw material (henceforth raw material student powder) is obtained. Next, raw material student powder was put into the alumina crucible, in the muffle furnace of reducing atmosphere, it calcinated at 1400 degrees C for 5 hours, and the fluorescent material burned product was obtained. Next, the burned product was ground and through and O (Sr0.952Eu0.03Dy0.015Tm0.003)-(aluminum 0.988B0.012) 2O3 fluorescent material with a mean particle diameter of 17 micrometers were obtained for the screen.

[0051] O (Sr0.952Eu0.03Dy0.015Tm0.003) and (aluminum 0.988B0.012) the 2O3 fluorescent-material 70 weight section, and the epoxy resin 120 weight section which were formed were often mixed, and it considered as the thriller. This thriller was made to pour in into the cup on the mounting lead with which the LED chip has been arranged. The resin which the afterglow nature fluorescent material contained was stiffened in 130-degree-C 1 hour after impregnation. In this way, the coating section which the afterglow nature fluorescent material with a thickness of 150micro contained was formed on the LED chip. In addition, the afterglow nature fluorescent material is gradually made [many] toward the LED chip at the coating section. Then, the translucency epoxy resin was made to form as a mold member in order to protect an LED chip and an afterglow nature fluorescent material from external force, moisture, dust, etc. further. The mold member inserted the leadframe by which the coating section of an afterglow nature fluorescent material was formed into the shuttering of a shell mold, and was made to harden it after mixing translucency EPOSHIKI resin in 150-degree-C 5 hours.

[0052] In this way, ** which the light emitting diode which has the obtained afterglow nature is saved [**] in a dark place where outdoor daylight is intercepted for 3 hours or more, and carries out continuation lighting for 5 minutes. The luminescent color of light blue green was obtained during lighting. Moreover, luminescence **** was 7.82 lm/w. The light was made to put out after carrying out continuation lighting of the light emitting diode for 5 minutes. The luminescent color of blue green was after putting out lights. The afterglow brightness 10 minutes after putting out lights was 421 mcd/m2. Light emitting diode was hardly fallen, when the afterglow brightness same after continuation 1000-hour lighting was measured.

[0053] (Example 1 of a comparison) Formation and a weatherability trial of light emitting diode were performed like the example 1 except having made the fluorescent material into O (Sr0.952Eu0.03Dy0.015Tm0.003)-(aluminum 0.988B0.012) 2O3 to ZnS:Cu. Immediately after energization, the formed light emitting diode had low brightness, although it was sure of luminescence of a Green blue system like the example 1. The light was made to put out after carrying out continuation lighting of the light emitting diode for 5 minutes. The luminescent color of blue green was after putting out lights. The afterglow brightness 10 minutes after putting out lights was 38 mcd/m2. Afterglow nature was undetectable when the afterglow brightness same after continuation 1000-hour lighting was measured for light emitting diode. As a result of analyzing a light emitting diode, the ZnS:Cu fluorescent material on an LED chip had deteriorated.

[0054] (Example 2) The light emitting diode of the invention in this application was used for the LED drop like drawing 4 (A). On the glass epoxy resin substrate in which the copper pattern was made to form, the light emitting diode made to form like an example 1 was arranged in 256 arrow-head configurations except having set the fluorescent material to O-1.75(Sr0.255Eu0.03Dy0.015Zr0.700) (aluminum 0.950B0.050) 2O3. A substrate and light emitting diode soldered using automatic pewter mounting equipment. Next, it was made to arrange and fix to the interior of the case formed with phenol resin. You made it filled up with some of cases, light emitting diodes, and substrates except for the point of light emitting diode by the silicone rubber colored black by the pigment. Then, silicone rubber was stiffened in ordinary temperature and 72 hours, and the LED drop was made to form. This LED drop and a driving means with a clock circuit were connected electrically, and the LED display equipment was constituted. It checked that repeated putting out lights for lighting 1 minute for 2 minutes, an LED drop was made to drive, and it could drive as a low power display.

[0055]

[Effect of the Invention] By considering as the configuration of claim 1 of the invention in this application using the light emitting device of a nitride-system compound semiconductor, and 2OO-n(M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent material, also in the use at

the time of quantity brightness, luminous efficiency is high for a long time, and the fall of luminescence **** or afterglow nature can consider as very little luminescence equipment etc. also in high brightness and prolonged use. Moreover, it is at the lighting and putting-out-lights time, and changing the luminescent color to arbitration can also be used as possible low power luminescence equipment.

[0056] Moreover, in addition to the ability of the fall of luminescence **** or afterglow nature to consider as very few light emitting diodes also in high brightness and prolonged use by considering as the configuration of claim 2 of the invention in this application, since a fluorescent material can distribute the luminescence unevenness of the LED chip itself, it can consider as the light emitting diode which has uniform luminescence.

[0057] By considering as the configuration of claim 3 of the invention in this application, also in the LED drop used for a location which is exposed to direct rays, such as the outdoors, it has afterglow nature, and can consider as a low power LED display equipment with few irregular colors with a check-by-looking include angle.

[0058]

[Translation done.]

* NOTICES *

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TECHNICAL FIELD

[Industrial Application] The invention in this application has the fluorescent material which a part of luminescence [at least] from the LED chip which is especially a light emitting device is changed [fluorescent material], and makes it emit light with respect to the luminescence equipment used for the back light light source, an LED indicator, an illumination type switch, various indicators, etc., and does not twist it to an operating environment, but relates to high brightness, and efficient, the luminescence equipment which has afterglow nature and the display using it.

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PRIOR ART

[Description of the Prior Art] Various displays are prepared today with development of portable electronic devices, such as a transceiver, a camera, a pocket bell, portable radio, a videocassette recorder, and a notebook sized personal computer, for operability or the improvement in visibility. There are some which used liquid crystal equipment for one of the display of this, and the back light is provided so that it can be used also in a dark place. Since there is a merit, like a time etc. increases, emitting light especially in a low power and high brightness is called for, so that it will carry out, if, as for the back light for portable electronic devices, such a back light reduces the power consumption. The thing which makes the light source from an LED chip emit light in high brightness by making light emit in the shape of a field etc. is in such one of the back light light sources. An LED chip is small and carries out luminescence of a color efficient and skillful in it. Moreover, since it is a semiconductor device, there are no worries about a ball piece etc. An initial drive property is excellent and it can consider as the back light light source using the description that it is strong to the repeat of vibration or ON/OFF lighting etc.

[0003] On the other hand, a duty of installation of a guide light is imposed upon locations in which there are many people and it gathers, such as a theater and a hotel, for the fire prevention regulations of the Fire Service Law enforcement ordinance and national each city etc. When a power source in ordinary use is severed by disaster, such as an earthquake and a fire, and other catastrophic failures, it changes to a standby power source automatically, and lighting for 20 minutes or more is needed. It can also consider as the drop which employed efficiently the property of the LED chip which is a high brightness low power also in such a guide light.

[0004] However, the back light made to form using an LED chip is a semi-conductor light emitting device, and although it is a low power, it consumes cell power. Therefore, it may become a big load in order to make it drive for a long time, when there are few amounts of accumulation of electricity of a cell power source. Moreover, the light may be put out, if the standby power source of a drop is destroyed at the time of disaster or a feeder circuit carries out a broken line etc. Therefore, when the case where there is little power, a feeder circuit, etc. stop, the drop which can display sufficient brightness is called for.

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EFFECT OF THE INVENTION

[Effect of the Invention] By considering as the configuration of claim 1 of the invention in this application using the light emitting device of a nitride system compound semiconductor, and 2O0-n(M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent material, also in the use at the time of quantity brightness, luminous efficiency is high for a long time, and the fall of luminescence **** or afterglow nature can consider as very little luminescence equipment etc. also in high brightness and prolonged use. Moreover, it is at the lighting and putting-out-lights time, and changing the luminescent color to arbitration can also be used as possible low power luminescence equipment.
[0056] Moreover, in addition to the ability of the fall of luminescence **** or afterglow nature to consider as very few light emitting diodes also in high brightness and prolonged use by considering as the configuration of claim 2 of the invention in this application, since a fluorescent material can distribute the luminescence unevenness of the LED chip itself, it can consider as the light emitting diode which has uniform luminescence.
[0057] By considering as the configuration of claim 3 of the invention in this application, also in the LED drop used for a location which is exposed to direct rays, such as the outdoors, it has afterglow nature, and can consider as a low power LED display equipment with few irregular colors with a check-by-looking include angle.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] The display which has light emitting diode and the fluorescent material excited by it as a display in alignment with such a request can be considered.
[0006] However, an LED chip has some which have various luminescence wavelength according to a presentation, structure, etc. of a semi-conductor. Similarly, various things, such as that to which the fluorescent material excited with an LED chip also has organic, an inorganic compound, and afterglow nature in fluorescent dye and a fluorescent pigment pan, are mentioned.
[0007] Moreover, when it approaches around an LED chip and arranges a fluorescent material, it is exposed to the beam of light of 40 times and the strong exposure reinforcement which reaches also more than it depending on the case from about 30 times rather than sunlight. When the amount of the improvement in conversion efficiency of a fluorescent material or the fluorescent material used is reduced using the semi-conductor which has a high energy band gap for the LED chip which is a light emitting device especially, even if it says that a light region has the main luminescence which emitted light from the LED chip, light energy becomes high inevitably. Moreover, if light may be emitted in an ultraviolet-rays field, luminescence reinforcement is raised further and it is used over a long period of time, the fluorescent material itself will tend to deteriorate. The fluorescent material similarly prepared near the LED chip is exposed also to elevated temperatures, such as heating from the temperature up and external environment of an LED chip. Furthermore, although the light emitting diode which is one sort of luminescence equipment is generally covered by resin mold, it cannot remove completely the moisture which adhered at the time of preventing penetration of the moisture from an external environment etc. completely, or manufacture. Depending on a fluorescent material, such moisture may promote degradation of a fluorescent material with the high energy light and the heat from a light emitting device. Moreover, when a fluorescent material deteriorates, there are that to which a fluorescent material becomes blackish and the external ejection effectiveness of light falls, and a remarkable case where afterglow nature becomes short. Furthermore, also when stopping showing afterglow nature, it is. Therefore, the invention in this application solves the above-mentioned technical problem, and it aims at offering the luminescence equipment with which decline in luminescence **** has afterglow nature very few under high brightness and the operating environment of long duration more.

[Translation done.]

MEANS

[Means for Solving the Problem] A luminous layer is luminescence equipment which has the LED chip which is a gallium nitride system compound semiconductor, and the fluorescent material which absorbs a part of luminescence [at least] from this LED chip, carries out wavelength conversion and emits light, said fluorescent material is activated with divalent europium, and the invention in this application is luminescence equipment whose chemical composition type is O-n (M1-p-qEupQq) (aluminum1-mBm) 2O3 while the main luminescence peak of said LED chip is in 360nm to 530nm. however, M in 0.0001<=p<=0.5, 0.0001<=q<=0.5, 0.5<=n<=10, 0<=m<=0.5, 0.0002 <=p+q<=0.75, and an empirical formula -- Mg -- it is at least one sort chosen from the group of the divalent metal which consists of calcium, Sr, Ba, and Zn, and Q is co-activating agent and is at least one sort chosen from the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu.

[0009] Moreover, the inner lead electrically connected to the LED chip arranged in the cup of a mounting lead, and this LED chip using the conductive wire, The coating member with which you made it filled up in said cup, and the mold member which covers a part of this coating member, an LED chip, conductive wire and mounting lead, and inner lead [at least], It is the light emitting diode which **** and said LED chip is a gallium nitride system compound semiconductor. And it is the light emitting diode which is translucency resin which said coating member is activated with divalent europium, and contains the fluorescent material whose chemical composition type is O-n (M1-p-qEupQq) (aluminum1-mBm) 2O3. however, M in 0.0001<=p<=0.5, 0.0001<=q<=0.5, 0.5<=n<=10, 0<=m<=0.5, 0.0002 <=p+q<=0.75, and an empirical formula -- Mg -- it is at least one sort chosen from the group of the divalent metal which consists of calcium, Sr, Ba, and Zn, and Q is co-activating agent and is at least one sort chosen from the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu.

[0010] Furthermore, it is the display which has the drive circuit which connected above-mentioned luminescence equipment to the drop arranged or more to two, and this drop electrically.

[0011]

[Embodiment of the Invention] As a result of various experiments, an invention-in-this-application person came to accomplish the header invention in this application for the ability of the fall of high brightness and the optical effectiveness at the time of use of long duration, or afterglow nature to be prevented, when light energy chooses a specific semi-conductor and a specific fluorescent material in the luminescence equipment which carries out wavelength conversion of a part of luminescence [at least] from a comparatively high LED chip with a fluorescent material.

[0012] That is, to excel in 1. lightfastness is demanded as a fluorescent material used for luminescence equipment. Since it strong-emanates from minute fields, such as a semi-conductor light emitting device, especially, it needs to be equal also to the strong exposure which reaches also 40 times from about 30 times of sunlight enough. 2. Since it is arranged near the light emitting device, the temperature characteristic be good. 3. Having the descriptions, like afterglow nature does not fall with the light of being [weatherability]-according to use environment of luminescence equipment 4. luminescence equipment, heat, etc. is called for.

[0013] The invention in this application uses O-n (aluminum1-mBm) 2O3 for the luminous layer of a light emitting device for the gallium nitride system compound semiconductor element which has a high energy band gap as a fluorescent material (M1-p-qEupQq) as what fulfills these conditions. Even if it is the case where the high energy light in the light region emitted from the light emitting device by this is irradiated near the long duration at high brightness, the fall of luminescence brightness or afterglow nature can consider as very little luminescence equipment.

[0014] As an example of concrete luminescence equipment, the chip type LED is shown in drawing 2 . The LED chip 202 which used the gallium nitride system semi-conductor is made to have fixed using an epoxy resin etc. in the chip type LED case 204. The gold streak is electrically connected to each electrode of the LED chip 202, and each electrode 205 in which it was prepared by the case as a conductive wire 203, respectively. (Sr0.952Eu0.03Dy0.015Tm0.003) Homogeneity is made to carry out hardening formation of what carried out mixed distribution of the O-(aluminum 0.988B0.012) 2O3 fluorescent material into the epoxy resin as a mold member 201 which protects an LED chip, a conductive wire, etc. from external force etc. The LED chip 202 is made to emit light by making such luminescence equipment supply power. The color mixture light of luminescence from the LED chip 202 and luminescence from the fluorescent material excited by the luminescence emits light. In after switching off an LED chip, it can consider as the luminescence equipment which can emit light only by the afterglow from a fluorescent material. Hereafter, the configuration member of the invention in this application is explained in full detail.

[0015] (Fluorescent material) The fluorescent material which is excited as a fluorescent material used for the invention in this application by the electromagnetic wave which emitted light from the semi-conductor luminous layer, and emits light is said. As a concrete fluorescent material, it is O-n (M1-p-qEupQq) (aluminum1-mBm) 2O3. Various things are mentioned as a use gestalt. It is good also considering opening which shuts up an LED chip in the bulk layer of a fluorescent material etc., and the light from an LED chip specifically penetrates in a fluorescent material layer as 1 thru/or luminescence equipment of a configuration of having two or more. Moreover, you may make it form in extent which is made to contain the fine particles of a fluorescent material in the resin which covers an LED chip, or glass, and the light from an LED chip penetrates thinly. Furthermore, you may make it mix in the edge strip between the light emitting diodes which arranged two or more light emitting diodes. Various color tones and afterglow nature can be chosen by choosing adjusting various ratios of the particle size of a fluorescent material, a fluorescent material, resin, etc., and spreading and fills, and the luminescence wavelength of a light emitting device.

[0016] Furthermore, content distribution of a fluorescent material influences color mixture nature, endurance, etc. That is, it is easy to

control degradation by moisture that it is harder to be influenced of the moisture from an external environment etc. toward an LED chip by the front-faces side, such as the coating section which the fluorescent material contained, and a mold member, when the distribution concentration of a fluorescent material is high. On the other hand, if distribution concentration becomes high toward an LED chip to a mold member front-face side about content distribution of a fluorescent material, although it will be easy to be influenced of the moisture from an external environment, the effect of generation of heat from an LED chip, exposure reinforcement, etc. can control degradation of a fluorescent material fewer. Such distribution of a fluorescent material can be made to form variously by making the member containing a fluorescent material, formation temperature, viscosity, the configuration of a fluorescent material, particle size distribution, etc. adjust. Therefore, various distribution concentration of a fluorescent material can be chosen according to a service condition etc.

[0017] or the fluorescent material used for the invention in this application touched the LED chip, when it approaches and has been arranged, it is enough -- it ********. Moreover, especially when the heat dissipation from an LED chip is large, 1.5 to 3 has desirable n. The activator and co-activating agent which are introduced into the afterglow nature fluorescent material of the invention in this application influence a fluorescence color and afterglow brightness greatly. Therefore, according to an application, it can adjust to the range as shown below, respectively.

[0018] That is, about the concentration p of Eu of an activator, it is desirable to adjust Sr of a parent to the range permuted 0.5 mols or less 0.0001 mols or more to one mol of fluorescent materials. This is because it is in the inclination for afterglow brightness to fall as a result by light absorption worsening when fewer than 0.0001 mols. On the contrary, when it increases more than 0.5 mols, it is in the inclination for lifting afterglow brightness to fall, about concentration quenching. When the range of p is $0.001 \leq p \leq 0.06$, afterglow brightness can make it high more.

[0019] Luminescence of Eu comes to show afterglow nature by introducing co-activating agent. it was chosen out of the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu as co-activating agent -- a kind is effective even if not few.

[0020] Especially in the case of Sr, divalent metal M of Dy which is the parent of a fluorescent material is effective on an afterglow disposition, and the density range of the Dy concentration q has 0.0005 or more and 0.03 or less desirable range. Similarly, as for Nd, in the case of calcium, divalent metal M which is the parent of a fluorescent material has effectiveness especially at especially the improvement in afterglow brightness, and the range of the Nd concentration q has 0.0005 or more and 0.03 or less desirable range. The synergistic effect can be demonstrated by 2nd activating other co-activating agent to these co-activating agent Dy and Nd.

[0021] When choosing Dy as the first co-activating agent, the range where the Mn concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and, specifically, 0.0005 or more and 0.02 or less range is still more desirable. Moreover, when choosing Dy as the first co-activating agent, the range where the Tm concentration q of the 2nd co-activating agent is desirable is 0.0003 or more and 0.02 or less, and 0.0004 or more and 0.01 or less range is still more desirable. Similarly, when choosing Dy as the first co-activating agent, the range where the Lu concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0004 or more and 0.04 or less range is still more desirable. When choosing Dy as the first co-activating agent, the range where the Nb concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.08 or less, and 0.0003 or more and 0.04 or less range is still more desirable. When choosing Dy as the first co-activating agent, the range where the Yb concentration q of the 2nd co-activating agent is desirable is 0.0002 or more and 0.04 or less, and 0.0003 or more and 0.01 or less range is still more desirable. When choosing Dy as the first co-activating agent, the range where the Zr concentration q of the 2nd co-activating agent is desirable is 0.002 or more and 0.70 or less. When choosing Dy as the first co-activating agent, the range where the Er concentration q of the second co-activating agent is desirable is 0.0001 or more and 0.03 or less. Furthermore, 0.0005 or more and 0.02 or less range is desirable. When choosing Dy as the first co-activating agent, the range where the Pr concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.04 or less. Furthermore, 0.0005 or more and 0.03 or less range is desirable.

[0022] When introducing Nd as the first co-activating agent, the range where the Tm concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable. When introducing Nd as the first co-activating agent, the range where the Pr concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable. When introducing Nd below as the first co-activating agent, the range where the Ho concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable. When introducing Nd below as the first co-activating agent, the range where the Dy concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable further again.

[0023] About the parent presentation of an afterglow nature fluorescent material, a part of aluminum can also be permuted by boron. In this case, the decay characteristic can also be made to improve still more greatly. Therefore, more preferably, the range which 0.5 mols of boron permute by the fluorescent material used for the invention in this application from 01 mols of the total number of mols of aluminum is desirable, and near 0.05 mol is [it is the range which becomes 0.25 mols from 0.005 mols, and] the most desirable. In order to introduce boron, it is desirable that only the amount corresponding to it deducts and teaches aluminum.

[0024] As for the afterglow nature fluorescent material used for the invention in this application, it is desirable to choose SrO, MgO, aluminum 2O3, a metallic oxide like Eu2O3, or a compound that turns into an oxide easily by calcinating at an elevated temperature like CaCO3, SrCO3, and BaCO3 as a raw material. Other than a carbonate, there are a nitrate, an oxalate, a hydroxide, etc. as such a compound. Moreover, as a boron compound, a boric acid or the borate of an alkaline earth can be used, and a boric acid is desirable especially. The purity of a raw material influences afterglow brightness greatly, it is desirable that it is 99.9% or more, and it is still more desirable that it is 99.99% or more. The raw material which mixed these can be calcinated under reducing atmosphere in 1200-degree-C or more temperature requirement 1600 degrees C or less, and a fluorescent material can be obtained for a burned product by grinding and carrying out a screen. In addition, the mixed ratio of a raw material can be determined by mixing the amount of theory for acquiring the target presentation.

[0025] Although the fluorescent material used for the invention in this application presents strong luminescence by divalent Eu of an activator fundamentally, divalent Eu has absorption in the large area of an ultraviolet area from the light. Therefore, even if it uses a gallium nitride system compound semiconductor, efficient luminescence is fully possible. Moreover, an afterglow phenomenon appears by making the parent of a fluorescent material dope at least one sort chosen from the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu as co-activating agent.

[0026] If boron is made to contain in an afterglow nature fluorescent material, the crystallinity of aluminates can be made good, and afterglow time amount and afterglow brightness can also be made to improve further by stabilizing an emission center and a trapping

center. Moreover, boron also has the effectiveness which works as flux to coincidence and promotes the crystal growth of a fluorescent material.

[0027] When the total number of mols of the total number of mols of the oxide of divalent metal, an activator, and co-activating agent, an alumina, and a boric acid is about 1:1, n= 1 [i.e.,], as a result of analyzing according to an X diffraction, the crystal structure serves as monoclinic system of SrAl2O4 mold, and green luminescence which has a peak in the wavelength of 520nm is shown. Moreover, although the low concentration whose permutation of boron is about 1 mol % shows the structure of SrAl 4O7 which should be generated from a preparation presentation when the total number of mols of the total number of mols of the oxide of divalent metal, an activator, and co-activating agent, an alumina, and a boric acid is taught to 1:2, n= 2 [i.e.,], and is calcinated, boron serves as mixture of Sr4aluminum 14O25 and SrAl 12O19 from this by high concentration. That is, by containing boron, the crystal structure can change and afterglow nature can also be raised. Similarly, at the time of n= 1.75, it can be set to Sr4aluminum 14O25, and thermal resistance etc. can also be raised more. As for such a presentation, it is desirable to make it choose in consideration of the purpose of use, the emission spectrum from an LED chip, or the excitation spectrum of a fluorescent material.

[0028] That is, the luminescent color can be changed to blue, a bluish green color, green, and Oshi by adjusting a parent presentation to the specific range. Moreover, by boron content to a parent presentation, stabilization of the crystal structure and particle growth can be promoted and high brightness-ization of afterglow can be attained as the result. Furthermore, when-izing of the afterglow brightness can be carried out [high brightness] further and especially Zr is chosen as the second co-activating agent with the combination of the first co-activating agent and the second co-activating agent, a luminescent color tone can also be changed.

[0029] In the luminescence equipment of the invention in this application, a fluorescent material may mix two or more kinds of 2OO-n (M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent materials. Two or more kinds of 2OO-n(M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent materials with which the element and content of M or Q differ from each other can be mixed, and a luminescence wavelength component can also be increased. Thereby, it can also consider as the luminescence equipment which can choose the various luminescent color. Moreover, it can consider as the multilayers which resin different, respectively was made to mix, and can also be made to excite by the semi-conductor light emitting device.

[0030] (LED chips 102, 202, 402, and 502) With the LED chip used for the invention in this application, the nitride system compound semiconductor which can excite efficiently 2OO-n(M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent material is mentioned. the LED chip which is a light emitting device -- MOCVD -- nitride system compound semiconductors, such as general formula InaAlbGa1-a-bN (however, 0<=a, 0<=b, a+b<1), are made to form as a luminous layer on a substrate by law etc. As structure of a semi-conductor, the thing of a terrorism configuration is mentioned to the gay structure, hetero structure, or double which has MIS junction, PIN junction, a PN junction, etc. Various luminescence wavelength can be chosen by whenever [ingredient or its mixed-crystal]. [of a semi-conductor layer] Moreover, it can also consider as the single quantum well structure and multiplex quantum well structure where the semi-conductor barrier layer was made to form in the thin film which the quantum effectiveness produces.

[0031] When a gallium nitride system compound semiconductor is used, ingredients, such as sapphire, a spinel, and SiC, Si, ZnO, are used for a semi-conductor substrate. In order to make crystalline good gallium nitride form, it is desirable to use a sapphire substrate. Buffer layers, such as GaN and AlN, are formed on this sapphire substrate, and the gallium nitride system semi-conductor which has a PN junction is made to form on it. A gallium nitride system semi-conductor shows N type conductivity in the condition of not doping an impurity. When making the N type gallium nitride semi-conductor of a request, such as raising luminous efficiency, form, it is desirable to introduce Si, germanium, Se, Te, C, etc. suitably as an N type dopant. On the other hand, when making a P type gallium nitride semi-conductor form, Zn, Mg, Be, calcium, Sr, Ba, etc. which are P type DOPANDO are made to dope. Only by doping a p-type dopant, since itis [P-type-] hard toize a gallium nitride system compound semiconductor, it is desirable to make it P-type-ize by annealing after p-type dopant installation by heating, the low-speed electron beam irradiation, the plasma exposure, etc. at a furnace. After making the exposure of a P-type semiconductor and an N-type semiconductor form by etching etc., the sputtering method, a vacuum deposition method, etc. are used and each electrode of a desired configuration is made to form on a semi-conductor layer.

[0032] Next, after carrying out direct full cutting with the dicing saw with which the blade which has the edge of a blade made from a diamond rotates the formed semi-conductor wafer or cutting the slot of width of face larger than edge-of-a-blade width of face deeply (half cutting), a semi-conductor wafer is broken according to external force. or the scriber in which the diamond stylus at a tip carries out both-way rectilinear motion -- a scribe line (circles of longitude) very thin to a semi-conductor wafer -- for example, after lengthening in a grid pattern, according to external force, a wafer is broken and it cuts in the shape of a chip from a semi-conductor wafer. Thus, the LED chip which is a gallium nitride system compound semiconductor can be made to form.

[0033] In the luminescence equipment of the invention in this application, efficiently, luminescence and when carrying out afterglow, in consideration of excitation wavelength with a fluorescent material etc., the luminescence wavelength of a light emitting device has 360nm or more desirable 530nm or less, and 380nm or more 490nm or less is more desirable. Moreover, in order to raise the property of luminescence equipment more in consideration of degradation of the mold member and coating material which were made to form by resin, or the color mixture of an LED chip and a fluorescent material, 400nm or more 475nm or less is still more desirable. The emission spectrum of the luminescence equipment which has the afterglow nature of the invention in this application is shown in drawing 3 . Luminescence which has a peak near 410nm is luminescence from an LED chip, and luminescence which has a peak near 520nm is luminescence of the fluorescent material excited with an LED chip. In addition, since the luminescence wavelength of less than 400nm includes an ultraviolet-rays region, it will have the monochromaticity of only luminescence from a fluorescent material.

[0034] (Conductive wires 103, 203, and 403) As conductive wires 103, 203, and 403, what has ohmic nature with the electrode of the LED chips 102, 202, and 502, mechanical-connections nature, good electrical conductivity, and good thermal conductivity is called for. As thermal conductivity, more than 0.01 cal/cm2/cm/degree C is desirable, and it is more than 0.5 cal/cm2/cm/degree C more preferably. Moreover, in consideration of workability etc., the diameters of a conductive wire are more than phi10micrometer and less than [phi45micrometer] preferably. Specifically, the conductive wire using metals and those alloys, such as gold, copper, platinum, and aluminum, as such a conductive wire is mentioned. Such a conductive wire can connect an inner lead, a mounting lead, etc. to the electrode of each LED chip easily by the wire-bonding device.

[0035] (Mounting lead 105) As mounting lead 105, the LED chip 102 is arranged and there should just be sufficient magnitude to load by die BONDODA etc. Moreover, when installing two or more LED chips and using a mounting lead as a common electrode of an LED chip, sufficient electrical conductivity and connectability with a bonding wire etc. are called for. Moreover, while arranging an LED chip in the cup on a mounting lead, when making the interior fill up with a fluorescent material, it can prevent carrying out false lighting by the light from another light emitting diode approached and arranged.

[0036] Thermosetting resin etc. can perform adhesion with the LED chip 102 and the cup of the mounting lead 105. Specifically, an epoxy resin, acrylic resin, imide resin, etc. are mentioned. Moreover, while making it paste up with a mounting lead with a face down LED chip etc., in order to make it connect electrically, Ag paste, carbon paste, an ITO paste, a metal bump, etc. can be used. Furthermore, in order to raise the efficiency for light utilization of a light emitting diode, the front face of the mounting lead with which an LED chip is arranged may be made into the shape of a mirror plane, and a reflex function may be given to a front face. As for the surface roughness in this case, less than [more than 0.1S0.8S] is desirable. Moreover, as concrete electric resistance of a mounting lead, below 300micro ohm-cm is desirable, and it is below 3micro ohm-cm more preferably. Moreover, when ****(ing) two or more LED chips on a mounting lead, since the calorific value from an LED chip increases, it is called for that thermal conductivity is good. concrete -- more than 0.01 cal/cm2/cm/degree C -- desirable -- more -- desirable -- It is more than 0.5 cal/cm2/cm/degree C. As an ingredient which fulfills these conditions, a ceramic with iron, copper, the copper containing iron, the copper containing tin, and a metallizing pattern etc. is mentioned.

[0037] (Inner lead 106) Connection with the conductive wire 103 connected with the LED chip 102 arranged on the mounting lead 105 as an inner lead 106 is aimed at. When two or more LED chips are prepared on a mounting lead, it is necessary to consider as the configuration which can be arranged so that each conductive wires may not contact. Specifically, contact of the conductive wire connected to the inner lead which is separated from a mounting lead can be prevented by enlarging area of the end face in which an inner lead carries out wire bonding etc. as it separates from a mounting lead. As for the granularity of a connection end face with a conductive wire, in consideration of adhesion, less than [more than 1.6S10S] is desirable. After making the configuration of a leadframe decide, pierce and form with shuttering beforehand or making all inner leads form, you may make it form by deleting a part of inner lead upper part, in order to make the point of an inner lead form in various configurations. Furthermore, a desired area and the desired end-face height of an end face can also be made to form in coincidence by piercing an inner lead and pressurizing from an end face after formation.

[0038] It is called for that connectability and electrical conductivity of an inner lead with the bonding wire which is a conductive wire are good. As concrete electric resistance, below 300micro ohm-cm is desirable, and it is below 3micro ohm-cm more preferably. As an ingredient which fulfills these conditions, the aluminum which plated iron, copper, the copper containing iron, the copper containing tin and copper, gold, and silver, iron, copper, etc. are mentioned.

[0039] (Coating sections 101 and 501) The afterglow nature fluorescent material which the mold member 104 is independently formed in the cup of a mounting lead, and changes luminescence of an LED chip contains the coating sections 101 and 501 used for the invention in this application. As a concrete ingredient of the coating section, transparence resin, glass, etc. excellent in weatherability, such as an epoxy resin, a urea resin, and silicone, are used suitably. Moreover, a color pigment, a coloring color, and a dispersing agent may be made to contain with a fluorescent material. A tint can also be made to adjust by using a color pigment and a coloring color. Moreover, an angle of beam spread can also be increased more by making a dispersing agent contain. As a concrete dispersing agent, barium titanate, titanium oxide, an aluminum oxide, oxidation silicon, etc. are used suitably.

[0040] (Mold members 104 and 404) The mold member 104 can be formed in order to protect from the exterior the coating section 101 which the LED chip 102, the conductive wire 103, and the fluorescent material contained according to the use application of a light emitting diode. A mold member can be made to form using glass or resin. Moreover, although an angle of visibility can be increased by making a fluorescent material contain, by making a mold member contain a dispersing agent, the directivity from the LED chip 102 can be made to be able to ease, and an angle of visibility can be increased further. Furthermore, the lens effectiveness which converge luminescence from an LED chip by making the mold member 104 into a desired configuration again, or it is made to diffuse can be given. Therefore, the structure which carried out two or more laminatings is sufficient as the mold member 104. Specifically, what saw from the luminescence observation side side and combined two or more elliptical and them is mentioned to a convex lens configuration and a concave lens configuration pan.

[0041] As a concrete ingredient of the mold member 104, transparence resin, glass, etc. which were mainly excellent in weatherability, such as an epoxy resin, a urea resin, and silicone, are used suitably. Moreover, as a dispersing agent, barium titanate, titanium oxide, an aluminum oxide, oxidation silicon, etc. are used suitably. Furthermore, a fluorescent material can also be made to contain also in a mold member in addition to a dispersing agent. Therefore, even if it makes it contain in a mold member, the other coating section etc. is made to contain a fluorescent material, and it may be used. Moreover, the resin with which the fluorescent material contained the coating section, and a mold member may be made to form using a different member used as glass etc. In this case, it can consider as light emitting diode with at best [productivity] more little effect of moisture etc. Moreover, a mold member and the coating section may be made to form using the same member in consideration of a refractive index.

[0042] (Display) As an example at the time of using the luminescence equipment of the invention in this application for an LED drop, the outline cross-section configuration of the LED drop which arranged luminescence equipment in desired configurations, such as an indicator and an arrow-head configuration, is shown in drawing 4 . Drawing 4 (A) puts in order the luminescence equipment with which the afterglow nature fluorescent material was mixed equally in the luminescence side top mold member of the LED chip 402, and drawing 4 (B) puts in order the luminescence equipment made to form on a coating member as light emitting diode in which the mold member 404 was made to form. Moreover, drawing 4 (C) shows the luminescence equipment which arranged the high-persistence fluorescent material content member 401 only in the direction of a perimeter of the field where the LED chip 402 emits light. It can consider as the display made to connect any luminescence equipment to the same drive circuit.

[0043] An LED drop is electrically connected to the lighting circuit which is a drive circuit. It can consider as the drop which makes a request turn on luminescence equipment by the output pulse from a drive circuit. It is switched with the output signal of the gradation control circuit which calculates the gradation signal for making predetermined brightness turn on each luminescence equipment from the data memorized by RAM (Random, Access, Memory) and RAM which make the data inputted memorize temporarily as a drive circuit, and a gradation control circuit, and has the driver which makes each luminescence equipment turn on. A gradation control circuit calculates the lighting time amount of luminescence equipment from the data memorized by RAM, and outputs it as a pulse signal etc. Here, if drive lighting of the luminescence equipment is carried out, in addition to the luminescent color from luminescence equipment, luminescence of a fluorescent material can also be displayed. Next, if luminescence equipment is made to switch off, it can consider as the drop with which the luminescent color of only the fluorescent material which has afterglow nature is emitting light. A color tone is also changeable by choosing each luminescence wavelength. Therefore, it can consider as the display which attracts attention also in a low power, night, etc.

[0044] (Field-like luminescence light source) Drawing 5 is the example which constituted the field-like luminescence light source using

the luminescence equipment of the invention in this application. The dispersion sheet 506 on the coating section or a light guide plate is made to contain a fluorescent material in the case of the field-like luminescence light source. Or it can also consider as the luminescence equipment which was made to carry out spreading etc. to the dispersion sheet 506, formed in the shape of [501] a sheet, and omitted the mold member with binder resin. Specifically, the LED chip 502 is fixed in the metal substrate 503 of the crevice configuration in which the insulating layer and the conductive pattern were formed. After taking an electric flow with an LED chip and the conductive pattern on a substrate, you make it filled up on the substrate 503 into which mixed churning of the fluorescent material was carried out with the epoxy resin, and the LED chip 502 was loaded, and luminescence equipment is made to form. In this way, the formed luminescence equipment is fixed to the end face of the acrylic light guide plate 504 with an epoxy resin etc. On one principal plane of a light guide plate 504, the reflective member 507 of the shape of a film which the white dispersion agent contained for luminescence unevenness prevention is arranged. Similarly the reflective member 505 is formed also on the end face by which the whole rear-face side surface or luminescence equipment of a light guide plate are not arranged, and luminescence **** is raised. It can consider as the field-like luminescence light source which can obtain brightness sufficient as a back light of LCD by this.

[0045] When using as a liquid crystal display, the polarizing plate arranged through the liquid crystal equipment poured in between the glass substrates with which the translucency conductivity pattern was formed on the principal plane of a light guide plate 504 can be made to constitute. Furthermore, when using it as a portable equipment etc., luminescence equipment, liquid crystal equipment, other operation means, etc. are connected to a cell power source. Moreover, it can have a comparison means in comparison with the set point which the value detected while having a detection means to detect the accumulation-of-electricity residue of a cell power source, ROM (Read On Memory), etc. were made to memorize, and a means to stop the power supplied to luminescence equipment when it makes it judge that it is made to compare and there are few accumulation-of-electricity residues than a request value. Other electrical circuits can be made to drive, making the life of a cell power source prolong by using an LED chip as an astigmatism LGT, or it will reduce the power supplied to an LED chip, if residues, such as a cell power source, become below constant value by this. Moreover, since the solution layer screen changes the luminescent color while being able to emit light efficiently with an afterglow nature fluorescent material, it can also recognize that there are few cell power sources. In this case, as for a fluorescent material, it is desirable to prepare on the shape of a dispersion sheet and the base of a light guide plate.

[0046] When using as a liquid crystal display, since outpatient department light is irradiated by the afterglow nature fluorescent material through a polarizing plate etc., excitation of the light from the outside may be 50% or less. Therefore, depending on outpatient department light, an internal afterglow nature fluorescent material is hard to be excited. Light can be made to shape[of a field]-emit efficiently by making an afterglow nature fluorescent substance emit light by the light emitting device. That is, the invention in this application can be taken as low power and the luminescence equipment which can emit light in high brightness. Although the example of the invention in this application is explained hereafter, it cannot be overemphasized that the invention in this application is not what is limited only to a concrete example.

[Translation done.]

EXAMPLE

[Example]
(Example 1) The GaInN semi-conductor whose main luminescence peak is 410nm as a light emitting device was used. the sapphire substrate top which made the LED chip wash -- TMG (trimethylgallium) gas, TMI (trimethyl in JUMU) gas, nitrogen gas, and dopant gas -- carrier gas -- a sink and MOCVD -- it was made to form by making a gallium nitride system compound semiconductor form by law The gallium nitride semi-conductor which has N type conductivity, and the gallium nitride semi-conductor which has P type conductivity were formed, and the PN junction was made to form by changing SiH4 and Cp2Mg as dopant gas. (In addition, a buffer layer is made to form on a sapphire substrate, and annealing of the P-type semiconductor has been carried out above 400 degrees C after membrane formation.)
[0048] After exposing PN each semi-conductor front face by etching, each electrode was made to form by the sputtering method, respectively. In this way, after lengthening a scribe line, external force was made to divide the done semi-conductor wafer, and the LED chip was made to form as a light emitting device.
[0049] Die bonding of the LED chip was carried out with the epoxy resin on the mounting lead which has a cup at the tip of the copper leadframe which carried out silver plating. Wire bonding of each electrode of an LED chip, a mounting lead, and the inner lead was carried out by the gold streak, respectively, and the electric flow was taken.
[0050] on the other hand -- a fluorescent material -- as a raw material -- SrCO3 -- 0.015 mols and Dy203 are put into 0.0075 mols, 0.0015 mols and H3BO3 are put [0.988 mols and Eu 2O3] into a 0.024-mol ceramic pot for Tm203, 0.952 mols and aluminum 2O3 are fully mixed with a ball mill, and a mixed raw material (henceforth raw material student powder) is obtained. Next, raw material student powder was put into the alumina crucible, in the muffle furnace of reducing atmosphere, it calcinated at 1400 degrees C for 5 hours, and the fluorescent material burned product was obtained. Next, the burned product was ground and through and O (Sr0.952Eu0.03Dy0.015Tm0.003)-(aluminum 0.988B0.012) 2O3 fluorescent material with a mean particle diameter of 17 micrometers were obtained for the screen.
[0051] O (Sr0.952Eu0.03Dy0.015Tm0.003) and (aluminum 0.988B0.012) the 2O3 fluorescent-material 70 weight section, and the epoxy resin 120 weight section which were formed were often mixed, and it considered as the thriller. This thriller was made to pour in into the cup on the mounting lead with which the LED chip has been arranged. The resin which the afterglow nature fluorescent material contained was stiffened in 130-degree-C 1 hour after impregnation. In this way, the coating section which the afterglow nature fluorescent material with a thickness of 150micro contained was formed on the LED chip. In addition, the afterglow nature fluorescent material is gradually made [many] toward the LED chip at the coating section. Then, the translucency epoxy resin was made to form as a mold member in order to protect an LED chip and an afterglow nature fluorescent material from external force, moisture, dust, etc. further. The mold member inserted the leadframe by which the coating section of an afterglow nature fluorescent material was formed into the shuttering of a shell mold, and was made to harden it after mixing translucency EPOSHIKI resin in 150-degree-C 5 hours.
[0052] In this way, ** which the light emitting diode which has the obtained afterglow nature is saved [**] in a dark place where outdoor daylight is intercepted for 3 hours or more, and carries out continuation lighting for 5 minutes. The luminescent color of light blue green was obtained during lighting. Moreover, luminescence **** was 7.82 lm/w. The light was made to put out after carrying out continuation lighting of the light emitting diode for 5 minutes. The luminescent color of blue green was after putting out lights. The afterglow brightness 10 minutes after putting out lights was 421 mcd/m2. Light emitting diode was hardly fallen, when the afterglow brightness same after continuation 1000-hour lighting was measured.
[0053] (Example 1 of a comparison) Formation and a weatherability trial of light emitting diode were performed like the example 1 except having made the fluorescent material into O (Sr0.952Eu0.03Dy0.015Tm0.003)-(aluminum 0.988B0.012) 2O3 to ZnS:Cu. Immediately after energization, the formed light emitting diode had low brightness, although it was sure of luminescence of a Green blue system like the example 1. The light was made to put out after carrying out continuation lighting of the light emitting diode for 5 minutes. The luminescent color of blue green was after putting out lights. The afterglow brightness 10 minutes after putting out lights was 38 mcd/m2. Afterglow nature was undetectable when the afterglow brightness same after continuation 1000-hour lighting was measured for light emitting diode. As a result of analyzing a light emitting diode, the ZnS:Cu fluorescent material on an LED chip had deteriorated.
[0054] (Example 2) The light emitting diode of the invention in this application was used for the LED drop like drawing 4 (A). On the glass epoxy resin substrate in which the copper pattern was made to form, the light emitting diode made to form like an example 1 was arranged in 256 arrow-head configurations except having set the fluorescent material to O-1.75(Sr0.255Eu0.03Dy0.015Zr0.700) (aluminum 0.950B0.050) 2O3. A substrate and light emitting diode soldered using automatic pewter mounting equipment. Next, it was made to arrange and fix to the interior of the case formed with phenol resin. You made it filled up with some of cases, light emitting diodes, and substrates except for the point of light emitting diode by the silicone rubber colored black by the pigment. Then, silicone rubber was stiffened in ordinary temperature and 72 hours, and the LED drop was made to form. This LED drop and a driving means with a clock circuit were connected electrically, and the LED display equipment was constituted. It checked that repeated putting out lights for lighting 1 minute for 2 minutes, an LED drop was made to drive, and it could drive as a low power display.

[Translation done.]

* NOTICES *

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is the typical sectional view of the luminescence equipment of the invention in this application.
[Drawing 2] Drawing 2 is the typical sectional view of other luminescence equipments of the invention in this application.
[Drawing 3] Drawing 3 is drawing having shown an example of the emission spectrum of the invention in this application.
[Drawing 4] Drawing 4 (A), (B), and (C) are the typical sectional views which used the luminescence equipment of the invention in this application for the display, respectively.
[Drawing 5] Drawing 5 is the mimetic diagram using the luminescence equipment of the invention in this application of an LED display equipment.
[Description of Notations]
101, 401, 501 ... The coating section which the fluorescent material contained
102, 202, 402, 502 ... LED chip
103, 403, 203 ... Conductive wire
104 404 ... Mold member
105 ... Mounting lead
106 ... Inner lead
201 ... Mold member which the fluorescent material contained
204 ... Case
205 ... Electrode prepared in the case
405 ... Electrode connected with the exterior
503 ... Metal substrate
504 ... Light guide plate
505 507 ... Reflective member
506 ... Dispersion sheet

[Translation done.]

* NOTICES *

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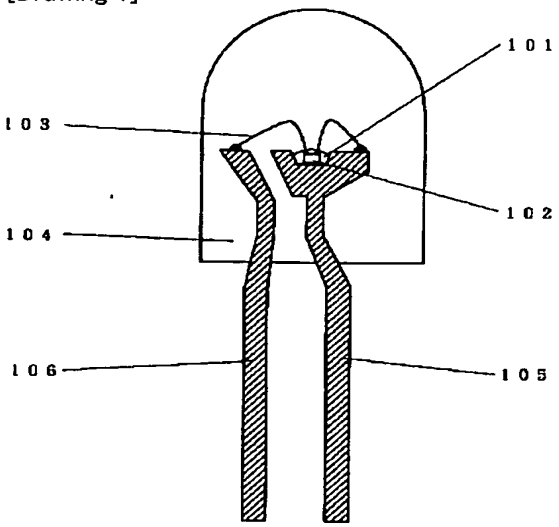
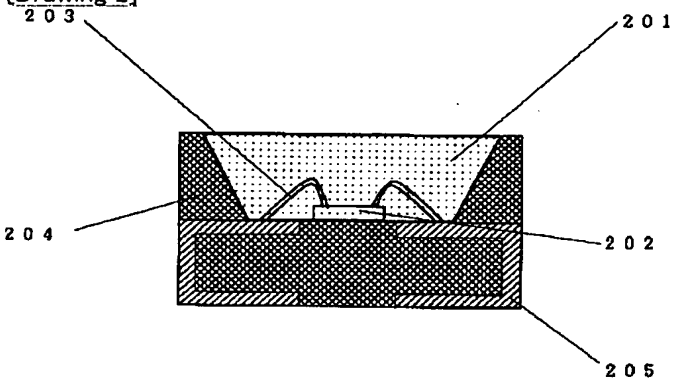
DRAWINGS

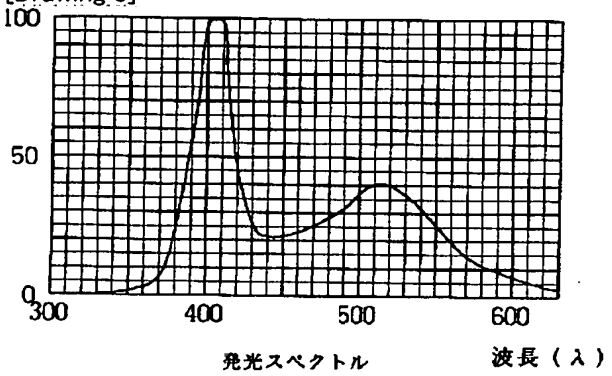
[Drawing 1]



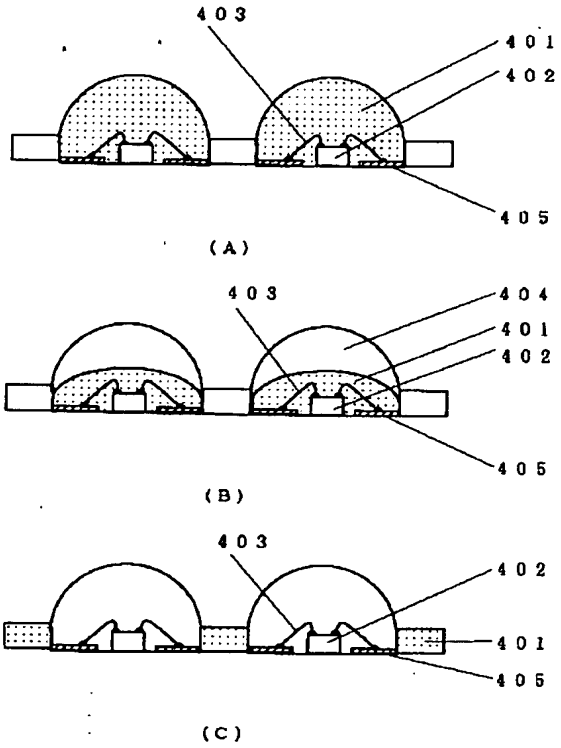
[Drawing 2]



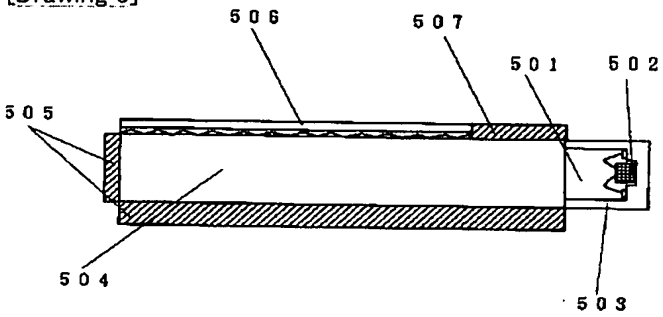
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]

* NOTICES *

CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Section partition] The 2nd partition of the 7th section
[Publication date] October 12, Heisei 13 (2001. 10.12)

[Publication No.] JP,10-112557,A
[Date of Publication] April 28, Heisei 10 (1998. 4.28)
[Annual volume number] Open patent official report 10-1126
[Application number] Japanese Patent Application No. 8-266450
[The 7th edition of International Patent Classification]

H01L 33/00

C09K 11/64 CPM
G09F 9/33

[FI]

H01L 33/00 N
C
C09K 11/64 CPM
G09F 9/33 E

[Procedure revision]
[Filing Date] January 15, Heisei 13 (2001. 1.15)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Whole sentence
[Method of Amendment] Modification
[Proposed Amendment]
[Document Name] Specification
[Title of the Invention] Luminescence equipment
[Claim(s)]
[Claim 1] It is luminescence equipment which has the LED chip (402) whose luminous layer is a gallium nitride system compound semiconductor, the mold member which covers this LED chip, and the edge strip (401) arranged in the direction of a perimeter of the mold member with which this LED chip was covered,
Said edge strip (401) is luminescence equipment characterized by coming to provide the fluorescent material which is excited by luminescence from said luminous layer and emits light.
[Claim 2] Said fluorescent material is luminescence equipment according to claim 1 whose chemical composition type it is activated with divalent europium and is O-n (M1-p-qEupQq) (aluminum1-mBm) 2O3.
however — 0.0001<=p<=0.5,
0.0001<=q<=0.5,
0.5<=n<=10,
0<=m<=0.5,
0.0002 <=p+q<=0.75,
M in an empirical formula is at least one sort chosen from the group of the divalent metal which consists of Mg, calcium, Sr, Ba, and Zn, and Q is co-activating agent and is at least one sort chosen from the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu.
[Claim 3] Said fluorescent material is luminescence equipment according to claim 1 to 2 with which it comes to mix two or more different kinds.
[Claim 4] Said edge strip (401) is luminescence equipment according to claim 1 to 3 which it comes to arrange among two or more light emitting diodes by which the LED chip was covered by the mold member.
[Detailed Description of the Invention]
[0001]
[Industrial Application] The invention in this application has the fluorescent material which a part of luminescence [at least] from the LED chip which is especially a light emitting device is changed [fluorescent material], and makes it emit light with respect to the luminescence equipment used for the back light light source, an LED indicator, an illumination type switch, various indicators, etc., and

does not twist it to an operating environment, but relates to high brightness, and efficient, the luminescence equipment which has afterglow nature and the display using it.
[0002]
[Description of the Prior Art] Various displays are prepared today with development of portable electronic devices, such as a transceiver, a camera, a pocket bell, portable radio, a videocassette recorder, and a notebook sized personal computer, for operability or the improvement in visibility. There are some which used liquid crystal equipment for one of the display of this, and the back light is provided so that it can be used also in a dark place. Since there is a merit, like a time etc. increases, emitting light especially in a low power and high brightness is called for, so that it will carry out, if, as for the back light for portable electronic devices, such a back light reduces the power consumption. The thing which makes the light source from an LED chip emit light in high brightness by making light emit in the shape of a field etc. is in such one of the back light light sources. An LED chip is small and carries out luminescence of a color efficient and skillful in it. Moreover, since it is a semiconductor device, there are no worries about a ball piece etc. An initial drive property is excellent and it can consider as the back light light source using the description that it is strong to the repeat of vibration or ON/OFF lighting etc.
[0003] On the other hand, a duty of installation of a guide light is imposed upon locations in which there are many people and it gathers, such as a theater and a hotel, for the fire prevention regulations of the Fire Service Law enforcement ordinance and national each city etc. When a power source in ordinary use is severed by disaster, such as an earthquake and a fire, and other catastrophic failures, it changes to a standby power source automatically, and lighting for 20 minutes or more is needed. It can also consider as the drop which employed efficiently the property of the LED chip which is a high brightness low power also in such a guide light.
[0004] However, the back light made to form using an LED chip is a semi-conductor light emitting device, and although it is a low power, it consumes cell power. Therefore, it may become a big load in order to make it drive for a long time, when there are few amounts of accumulation of electricity of a cell power source. Moreover, the light may be put out, if the standby power source of a drop is destroyed at the time of disaster or a feeder circuit carries out a broken line etc. Therefore, when the case where there is little power, a feeder circuit, etc. stop, the drop which can display sufficient brightness is called for.
[0005]
[Problem(s) to be Solved by the Invention] The display which has light emitting diode and the fluorescent material excited by it as a display in alignment with such a request can be considered.
[0006] However, an LED chip has some which have various luminescence wavelength according to a presentation, structure, etc. of a semi-conductor. Similarly, various things, such as that to which the fluorescent material excited with an LED chip also has organic, an inorganic compound, and afterglow nature in fluorescent dye and a fluorescent pigment pan, are mentioned.
[0007] Moreover, when it approaches around an LED chip and arranges a fluorescent material, it is exposed to the beam of light of 40 times and the strong exposure reinforcement which reaches also more than it depending on the case from about 30 times rather than sunlight. When the amount of the improvement in conversion efficiency of a fluorescent material or the fluorescent material used is especially reduced using the semi-conductor which has a high energy band gap for the LED chip which is a light emitting device, even if it says that a light region has the main luminescence which emitted light from the LED chip, light energy becomes high inevitably. Moreover, if light may be emitted in an ultraviolet-rays field, luminescence reinforcement is raised further and it is used over a long period of time, the fluorescent material itself will tend to deteriorate. The fluorescent material similarly prepared near the LED chip is exposed also to elevated temperatures, such as heating from the temperature up and external environment of an LED chip. Furthermore, although the light emitting diode which is one sort of luminescence equipment is generally covered by resin mold, it cannot remove completely the moisture which adhered at the time of preventing penetration of the moisture from an external environment etc. completely, or manufacture. Depending on a fluorescent material, such moisture may promote degradation of a fluorescent material with the high energy light and the heat from a light emitting device. Moreover, when a fluorescent material deteriorates, there are that to which a fluorescent material becomes blackish and the external ejection effectiveness of light falls, and a remarkable case where afterglow nature becomes short. Furthermore, also when stopping showing afterglow nature, it is. Therefore, the invention in this application solves the above-mentioned technical problem, and it aims at offering the luminescence equipment with which decline in luminescence **** has afterglow nature very few under high brightness and the operating environment of long duration more.
[0008]
[Means for Solving the Problem] The invention in this application is luminescence equipment which comes to provide the fluorescent material which an edge strip (401) is excited by luminescence from a luminous layer in the luminescence equipment which has the LED chip (402) whose luminous layer is a gallium nitride system compound semiconductor, the mold member which covers an LED chip, and the edge strip (401) arranged in the direction of a perimeter of the mold member with which the LED chip was covered, and emits light.
[0009] Moreover, luminescence equipment according to claim 2 is activated with europium divalent in a fluorescent material, and a chemical composition type is O-n (M1-p-qEupQq) (aluminum1-mBm) 2O3. however, M in 0.0001<=p<=0.5, 0.0001<=q<=0.5, 0.5<=n<=10, 0<=m<=0.5, 0.0002 <=p+q<=0.75, and an empirical formula -- Mg -- it is at least one sort chosen from the group of the divalent metal which consists of calcium, Sr, Ba, and Zn, and Q is co-activating agent and is at least one sort chosen from the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu.
[0010] Furthermore, it comes to arrange ** with which it comes to mix two or more kinds from which, as for luminescence equipment according to claim 3, a fluorescent material differs, and luminescence equipment according to claim 4 among two or more light emitting diodes with which the LED chip was covered for the edge strip (401) by the mold member.
[0011]
[Embodiment of the Invention] As a result of various experiments, an invention-in-this-application person came to accomplish the header invention in this application for the ability of the fall of high brightness and the optical effectiveness at the time of use of long duration, or afterglow nature to be prevented, when light energy chooses a specific semi-conductor and a specific fluorescent material in the luminescence equipment which carries out wavelength conversion of a part of luminescence [at least] from a comparatively high LED chip with a fluorescent material.
[0012] That is, it is a fluorescent material used for luminescence equipment,
1. To excel in lightfastness is demanded. Since it strong-emanates from minute fields, such as a semi-conductor light emitting device, especially, it needs to be equal also to the strong exposure which reaches also 40 times from about 30 times of sunlight enough. 2. Since it is arranged near the light emitting device, the temperature characteristic be good. 3. Having the descriptions, like afterglow nature does not fall with the light of being [weatherability]-according to use environment of luminescence equipment 4. luminescence

equipment, heat, etc. is called for.
[0013] The invention in this application uses O-n (aluminum1-mBm) 2O3 for the luminous layer of a light emitting device for the gallium nitride system compound semiconductor element which has a high energy band gap as a fluorescent material (M1-p-qEupQq) as what fulfills these conditions. Even if it is the case where the high energy light in the light region emitted from the light emitting device by this is irradiated near the long duration at high brightness, the fall of luminescence brightness or afterglow nature can consider as very little luminescence equipment.
[0014] As an example of concrete luminescence equipment, the chip type LED is shown in drawing 2. The LED chip 202 which used the gallium nitride system semi-conductor is made to have fixed using an epoxy resin etc. in the chip type LED case 204. The gold streak is electrically connected to each electrode of the LED chip 202, and each electrode 205 in which it was prepared by the case as a conductive wire 203, respectively. (Sr0.952Eu0.03Dy0.015Tm0.003) Homogeneity is made to carry out hardening formation of what carried out mixed distribution of the O-(aluminum 0.988B0.012) 2O3 fluorescent material into the epoxy resin as a mold member 201 which protects an LED chip, a conductive wire, etc. from external force etc. The LED chip 202 is made to emit light by making such luminescence equipment supply power. The color mixture light of luminescence from the LED chip 202 and luminescence from the fluorescent material excited by the luminescence emits light. In after switching off an LED chip, it can consider as the luminescence equipment which can emit light only by the afterglow from a fluorescent material. Hereafter, the configuration member of the invention in this application is explained in full detail.
[0015] (Fluorescent material) The fluorescent material which is excited as a fluorescent material used for the invention in this application by the electromagnetic wave which emitted light from the semi-conductor luminous layer, and emits light is said. As a concrete fluorescent material, it is O-n (M1-p-qEupQq) (aluminum1-mBm) 2O3. Various things are mentioned as a use gestalt. It is good also considering opening which shuts up an LED chip in the bulk layer of a fluorescent material etc., and the light from an LED chip specifically penetrates in a fluorescent material layer as 1 thru/or luminescence equipment of a configuration of having two or more. Moreover, you may make it form in extent which is made to contain the fine particles of a fluorescent material in the resin which covers an LED chip, or glass, and the light from an LED chip penetrates thinly. Furthermore, you may make it mix in the edge strip between the light emitting diodes which arranged two or more light emitting diodes. Various color tones and afterglow nature can be chosen by choosing adjusting various ratios of the particle size of a fluorescent material, a fluorescent material, resin, etc., and spreading and fills, and the luminescence wavelength of a light emitting device.
[0016] Furthermore, content distribution of a fluorescent material influences color mixture nature, endurance, etc. That is, it is easy to control degradation by moisture that it is harder to be influenced of the moisture from an external environment etc. toward an LED chip by the front-faces side, such as the coating section which the fluorescent material contained, and a mold member, when the distribution concentration of a fluorescent material is high. On the other hand, if distribution concentration becomes high toward an LED chip to a mold member front-face side about content distribution of a fluorescent material, although it will be easy to be influenced of the moisture from an external environment, the effect of generation of heat from an LED chip, exposure reinforcement, etc. can control degradation of a fluorescent material fewer. Such distribution of a fluorescent material can be made to form variously by making the member containing a fluorescent material, formation temperature, viscosity, the configuration of a fluorescent material, particle size distribution, etc. adjust. Therefore, various distribution concentration of a fluorescent material can be chosen according to a service condition etc.
[0017] or the fluorescent material used for the invention in this application touched the LED chip, when it approaches and has been arranged, it is enough — it ********. Moreover, especially when the heat dissipation from an LED chip is large, 1.5 to 3 has desirable n. The activator and co-activating agent which are introduced into the afterglow nature fluorescent material of the invention in this application influence a fluorescence color and afterglow brightness greatly. Therefore, according to an application, it can adjust to the range as shown below, respectively.
[0018] That is, about the concentration p of Eu of an activator, it is desirable to adjust Sr of a parent to the range permuted 0.5 mols or less 0.0001 mols or more to one mol of fluorescent materials. This is because it is in the inclination for afterglow brightness to fall as a result by light absorption worsening when fewer than 0.0001 mols. On the contrary, when it increases more than 0.5 mols, it is in the inclination for lifting afterglow brightness to fall, about concentration quenching. When the range of p is $0.001 \leq p \leq 0.06$, afterglow brightness can make it high more.
[0019] Luminescence of Eu comes to show afterglow nature by introducing co-activating agent. it was chosen out of the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu as co-activating agent — a kind is effective even if not few.
[0020] Especially in the case of Sr, divalent metal M of Dy which is the parent of a fluorescent material is effective on an afterglow disposition, and the density range of the Dy concentration q has 0.0005 or more and 0.03 or less desirable range. Similarly, as for Nd, in the case of calcium, divalent metal M which is the parent of a fluorescent material has effectiveness especially at especially the improvement in afterglow brightness, and the range of the Nd concentration q has 0.0005 or more and 0.03 or less desirable range. The synergistic effect can be demonstrated by 2nd activating other co-activating agent to these co-activating agent Dy and Nd.
[0021] When choosing Dy as the first co-activating agent, the range where the Mn concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and, specifically, 0.0005 or more and 0.02 or less range is still more desirable. Moreover, when choosing Dy as the first co-activating agent, the range where the Tm concentration q of the 2nd co-activating agent is desirable is 0.0003 or more and 0.02 or less, and 0.0004 or more and 0.01 or less range is still more desirable. Similarly, when choosing Dy as the first co-activating agent, the range where the Lu concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0004 or more and 0.04 or less range is still more desirable. When choosing Dy as the first co-activating agent, the range where the Nb concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.08 or less, and 0.0003 or more and 0.04 or less range is still more desirable. When choosing Dy as the first co-activating agent, the range where the Yb concentration q of the 2nd co-activating agent is desirable is 0.0002 or more and 0.04 or less, and 0.0003 or more and 0.01 or less range is still more desirable. When choosing Dy as the first co-activating agent, the range where the Zr concentration q of the 2nd co-activating agent is desirable is 0.002 or more and 0.70 or less. When choosing Dy as the first co-activating agent, the range where the Er concentration q of the second co-activating agent is desirable is 0.0001 or more and 0.03 or less. Furthermore, 0.0005 or more and 0.02 or less range is desirable. When choosing Dy as the first co-activating agent, the range where the Pr concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.04 or less. Furthermore, 0.0005 or more and 0.03 or less range is desirable.
[0022] When introducing Nd as the first co-activating agent, the range where the Tm concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable. When introducing Nd as

the first co-activating agent, the range where the Pr concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable. When introducing Nd below as the first co-activating agent, the range where the Ho concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable. When introducing Nd below as the first co-activating agent, the range where the Dy concentration q of the 2nd co-activating agent is desirable is 0.0001 or more and 0.06 or less, and 0.0005 or more and 0.02 or less range is still more desirable further again.

[0023] About the parent presentation of an afterglow nature fluorescent material, a part of aluminum can also be permuted by boron. In this case, the decay characteristic can also be made to improve still more greatly. Therefore, more preferably, the range which 0.5 mols of boron permute by the fluorescent material used for the invention in this application from 01 mols of the total number of mols of aluminum is desirable, and near 0.05 mol is [it is the range which becomes 0.25 mols from 0.005 mols, and] the most desirable. In order to introduce boron, it is desirable that only the amount corresponding to it deducts and teaches aluminum.

[0024] As for the afterglow nature fluorescent material used for the invention in this application, it is desirable to choose SrO, MgO, aluminum 2O3, a metallic oxide like Eu2O3, or a compound that turns into an oxide easily by calcinating at an elevated temperature like CaCO3, SrCO3, and BaCO3 as a raw material. Other than a carbonate, there are a nitrate, an oxalate, a hydroxide, etc. as such a compound. Moreover, as a boron compound, a boric acid or the borate of an alkaline earth can be used, and a boric acid is desirable especially. The purity of a raw material influences afterglow brightness greatly, it is desirable that it is 99.9% or more, and it is still more desirable that it is 99.99% or more. The raw material which mixed these can be calcinated under reducing atmosphere in 1200-degree-C or more temperature requirement 1600 degrees C or less, and a fluorescent material can be obtained for a burned product by grinding and carrying out a screen. In addition, the mixed ratio of a raw material can be determined by mixing the amount of theory for acquiring the target presentation.

[0025] Although the fluorescent material used for the invention in this application presents strong luminescence by divalent Eu of an activator fundamentally, divalent Eu has absorption in the large area of an ultraviolet area from the light. Therefore, even if it uses a gallium nitride system compound semiconductor, efficient luminescence is fully possible. Moreover, an afterglow phenomenon appears by making the parent of a fluorescent material dope at least one sort chosen from the group which consists of Mn, Zr, Nb, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu as co-activating agent.

[0026] If boron is made to contain in an afterglow nature fluorescent material, the crystallinity of aluminates can be made good, and afterglow time amount and afterglow brightness can also be made to improve further by stabilizing an emission center and a trapping center. Moreover, boron also has the effectiveness which works as flux to coincidence and promotes the crystal growth of a fluorescent material.

[0027] When the total number of mols of the total number of mols of the oxide of divalent metal, an activator, and co-activating agent, an alumina, and a boric acid is about 1:1, n= 1 [i.e.,], as a result of analyzing according to an X diffraction, the crystal structure serves as monoclinic system of SrAl2O4 mold, and green luminescence which has a peak in the wavelength of 520nm is shown. Moreover, although the low concentration whose permutation of boron is about 1 mol % shows the structure of SrAl 4O7 which should be generated from a preparation presentation when the total number of mols of the total number of mols of the oxide of divalent metal, an activator, and co-activating agent, an alumina, and a boric acid is taught to 1:2, n= 2 [i.e.,], and is calcinated, boron serves as mixture of Sr4aluminum 14O25 and SrAl 12O19 from this by high concentration. That is, by containing boron, the crystal structure can change and afterglow nature can also be raised. Similarly, at the time of n= 1.75, it can be set to Sr4aluminum 14O25, and thermal resistance etc. can also be raised more. As for such a presentation, it is desirable to make it choose in consideration of the purpose of use, the emission spectrum from an LED chip, or the excitation spectrum of a fluorescent material.

[0028] That is, the luminescent color can be changed to blue, a bluish green color, green, and Oshi by adjusting a parent presentation to the specific range. Moreover, by boron content to a parent presentation, stabilization of the crystal structure and particle growth can be promoted and high brightness-ization of afterglow can be attained as the result. Furthermore, when-izing of the afterglow brightness can be carried out [high brightness] further and especially Zr is chosen as the second co-activating agent with the combination of the first co-activating agent and the second co-activating agent, a luminescent color tone can also be changed.

[0029] In the luminescence equipment of the invention in this application, a fluorescent material may mix two or more kinds of 2OO-n (M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent materials. Two or more kinds of 2OO-n(M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent materials with which the element and content of M or Q differ from each other can be mixed, and a luminescence wavelength component can also be increased. Thereby, it can also consider as the luminescence equipment which can choose the various luminescent color. Moreover, it can consider as the multilayers which resin different, respectively was made to mix, and can also be made to excite by the semi-conductor light emitting device.

[0030] (LED chips 102, 202, 402, and 502) With the LED chip used for the invention in this application, the nitride system compound semiconductor which can excite efficiently 2OO-n(M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent material is mentioned. the LED chip which is a light emitting device -- MOCVD -- nitride system compound semiconductors, such as general formula InaAlbGa1-a-bN (however, 0<=a, 0<=b, a+b<1), are made to form as a luminous layer on a substrate by law etc. As structure of a semi-conductor, the thing of a terrorism configuration is mentioned to the gay structure, hetero structure, or double which has MIS junction, PIN junction, pn junction, etc. Various luminescence wavelength can be chosen by whenever [ingredient or its mixed-crystal]. [of a semi-conductor layer] Moreover, it can also consider as the single quantum well structure and multiplex quantum well structure where the semi-conductor barrier layer was made to form in the thin film which the quantum effectiveness produces.

[0031] When a gallium nitride system compound semiconductor is used, ingredients, such as sapphire, a spinel, and SiC, Si, ZnO, are used for a semi-conductor substrate. In order to make crystalline good gallium nitride form, it is desirable to use a sapphire substrate. Buffer layers, such as GaN and AlN, are formed on this sapphire substrate, and the gallium nitride system semi-conductor which has pn junction is made to form on it. A gallium nitride system semi-conductor shows n mold conductivity in the condition of not doping an impurity. When making n mold gallium nitride semi-conductor of a request, such as raising luminous efficiency, form, it is desirable to introduce Si, germanium, Se, Te, C, etc. suitably as an n mold dopant. On the other hand, when making p mold gallium nitride semi-conductor form, Zn, Mg, Be, calcium, Sr, Ba, etc. which are p mold DOPANDO are made to dope. Only by doping p mold dopant, since it is hard to form a gallium nitride system compound semiconductor into p mold, it is desirable to make p mold form by annealing after p mold dopant installation by heating, the low-speed electron beam irradiation, the plasma exposure, etc. at a furnace. After making the exposure of a P-type semiconductor and an N-type semiconductor form by etching etc., the sputtering method, a vacuum deposition method, etc. are used and each electrode of a desired configuration is made to form on a semi-conductor layer.

[0032] Next, after carrying out direct full cutting with the dicing saw with which the blade which has the edge of a blade made from a diamond rotates the formed semi-conductor wafer or cutting the slot of width of face larger than edge-of-a-blade width of face deeply (half cutting), a semi-conductor wafer is broken according to external force. or the scriber in which the diamond stylus at a tip carries out both-way rectilinear motion -- a scribe line (circles of longitude) very thin to a semi-conductor wafer -- for example, after lengthening in a grid pattern, according to external force, a wafer is broken and it cuts in the shape of a chip from a semi-conductor wafer. Thus, the LED chip which is a gallium nitride system compound semiconductor can be made to form.
[0033] In the luminescence equipment of the invention in this application, efficiently, luminescence and when carrying out afterglow, in consideration of excitation wavelength with a fluorescent material etc., the luminescence wavelength of a light emitting device has 360nm or more desirable 530nm or less, and 380nm or more 490nm or less is more desirable. Moreover, in order to raise the property of luminescence equipment more in consideration of degradation of the mold member and coating material which were made to form by resin, or the color mixture of an LED chip and a fluorescent material, 400nm or more 475nm or less is still more desirable. The emission spectrum of the luminescence equipment which has the afterglow nature of the invention in this application is shown in drawing 3. Luminescence which has a peak near 410nm is luminescence from an LED chip, and luminescence which has a peak near 520nm is luminescence of the fluorescent material excited with an LED chip. In addition, since the luminescence wavelength of less than 400nm includes an ultraviolet-rays region, it will have the monochromaticity of only luminescence from a fluorescent material.
[0034] (Conductive wires 103, 203, and 403) As conductive wires 103, 203, and 403, what has ohmic nature with the electrode of the LED chips 102, 202, and 502, mechanical-connections nature, good electrical conductivity, and good thermal conductivity is called for. As thermal conductivity, more than 0.01 cal/cm2/cm/degree C is desirable, and it is more than 0.5 cal/cm2/cm/degree C more preferably. Moreover, in consideration of workability etc., the diameters of a conductive wire are more than phi10micrometer and less than [phi45micrometer] preferably. Specifically, the conductive wire using metals and those alloys, such as gold, copper, platinum, and aluminum, as such a conductive wire is mentioned. Such a conductive wire can connect an inner lead, a mounting lead, etc. to the electrode of each LED chip easily by the wire-bonding device.
[0035] (Mounting lead 105) As mounting lead 105, the LED chip 102 is arranged and there should just be sufficient magnitude to load by die BONDODA etc. Moreover, when installing two or more LED chips and using a mounting lead as a common electrode of an LED chip, sufficient electrical conductivity and connectability with a bonding wire etc. are called for. Moreover, while arranging an LED chip in the cup on a mounting lead, when making the interior fill up with a fluorescent material, it can prevent carrying out false lighting by the light from another light emitting diode approached and arranged.
[0036] Thermosetting resin etc. can perform adhesion with the LED chip 102 and the cup of the mounting lead 105. Specifically, an epoxy resin, acrylic resin, imide resin, etc. are mentioned. Moreover, while making it paste up with a mounting lead with a face down LED chip etc., in order to make it connect electrically, Ag paste, carbon paste, an ITO paste, a metal bump, etc. can be used. Furthermore, in order to raise the efficiency for light utilization of a light emitting diode, the front face of the mounting lead with which an LED chip is arranged may be made into the shape of a mirror plane, and a reflex function may be given to a front face. As for the surface roughness in this case, less than [more than 0.1S0.8S] is desirable. Moreover, as concrete electric resistance of a mounting lead, below 300micro ohm-cm is desirable, and it is below 3micro ohm-cm more preferably. Moreover, when ****(ing) two or more LED chips on a mounting lead, since the calorific value from an LED chip increases, it is called for that thermal conductivity is good. concrete -- more than 0.01 cal/cm2/cm/degree C -- desirable -- more -- desirable -- It is more than 0.5 cal/cm2/cm/degree C. As an ingredient which fulfills these conditions, a ceramic with iron, copper, the copper containing iron, the copper containing tin, and a metallizing pattern etc. is mentioned.
[0037] (Inner lead 106) Connection with the conductive wire 103 connected with the LED chip 102 arranged on the mounting lead 105 as an inner lead 106 is aimed at. When two or more LED chips are prepared on a mounting lead, it is necessary to consider as the configuration which can be arranged so that each conductive wires may not contact. Specifically, contact of the conductive wire connected to the inner lead which is separated from a mounting lead can be prevented by enlarging area of the end face in which an inner lead carries out wire bonding etc. as it separates from a mounting lead. As for the granularity of a connection end face with a conductive wire, in consideration of adhesion, less than [more than 1.6S10S] is desirable. After making the configuration of a leadframe decide, pierce and form with shuttering beforehand or making all inner leads form, you may make it form by deleting a part of inner lead upper part, in order to make the point of an inner lead form in various configurations. Furthermore, a desired area and the desired end-face height of an end face can also be made to form in coincidence by piercing an inner lead and pressurizing from an end face after formation.
[0038] It is called for that connectability and electrical conductivity of an inner lead with the bonding wire which is a conductive wire are good. As concrete electric resistance, below 300micro ohm-cm is desirable, and it is below 3micro ohm-cm more preferably. As an ingredient which fulfills these conditions, the aluminum which plated iron, copper, the copper containing iron, the copper containing tin and copper, gold, and silver, iron, copper, etc. are mentioned.
[0039] (Coating sections 101 and 501) The afterglow nature fluorescent material which the mold member 104 is independently formed in the cup of a mounting lead, and changes luminescence of an LED chip contains the coating sections 101 and 501 used for the invention in this application. As a concrete ingredient of the coating section, transparence resin, glass, etc. excellent in weatherability, such as an epoxy resin, a urea resin, and silicone, are used suitably. Moreover, a color pigment, a coloring color, and a dispersing agent may be made to contain with a fluorescent material. A tint can also be made to adjust by using a color pigment and a coloring color. Moreover, an angle of beam spread can also be increased more by making a dispersing agent contain. As a concrete dispersing agent, barium titanate, titanium oxide, an aluminum oxide, oxidation silicon, etc. are used suitably.
[0040] (Mold members 104 and 404) The mold member 104 can be formed in order to protect from the exterior the coating section 101 which the LED chip 102, the conductive wire 103, and the fluorescent material contained according to the use application of a light emitting diode. A mold member can be made to form using glass or resin. Moreover, although an angle of visibility can be increased by making a fluorescent material contain, by making a mold member contain a dispersing agent, the directivity from the LED chip 102 can be made to be able to ease, and an angle of visibility can be increased further. Furthermore, the lens effectiveness which converge luminescence from an LED chip by making the mold member 104 into a desired configuration again, or it is made to diffuse can be given. Therefore, the structure which carried out two or more laminatings is sufficient as the mold member 104. Specifically, what saw from the luminescence observation side side and combined two or more elliptical and them is mentioned to a convex lens configuration and a concave lens configuration pan.
[0041] As a concrete ingredient of the mold member 104, transparence resin, glass, etc. which were mainly excellent in weatherability,

such as an epoxy resin, a urea resin, and silicone, are used suitably. Moreover, as a dispersing agent, barium titanate, titanium oxide, an aluminum oxide, oxidation silicon, etc. are used suitably. Furthermore, a fluorescent material can also be made to contain also in a mold member in addition to a dispersing agent. Therefore, even if it makes it contain in a mold member, the other coating section etc. is made to contain a fluorescent material, and it may be used. Moreover, the resin with which the fluorescent material contained the coating section, and a mold member may be made to form using a different member used as glass etc. In this case, it can consider as light emitting diode with at best [productivity] more little effect of moisture etc. Moreover, a mold member and the coating section may be made to form using the same member in consideration of a refractive index.

[0042] (Display) As an example at the time of using the luminescence equipment of the invention in this application for an LED drop, the outline cross-section configuration of the LED drop which arranged luminescence equipment in desired configurations, such as an indicator and an arrow-head configuration, is shown in drawing 4. Drawing 4 (A) puts in order the luminescence equipment with which the afterglow nature fluorescent material was mixed equally in the luminescence side top mold member of the LED chip 402, and drawing 4 (B) puts in order the luminescence equipment made to form on a coating member as light emitting diode in which the mold member 404 was made to form. Moreover, drawing 4 (C) shows the luminescence equipment which arranged the high-persistence fluorescent material content member 401 only in the direction of a perimeter of the field where the LED chip 402 emits light. It can consider as the display made to connect any luminescence equipment to the same drive circuit.

[0043] An LED drop is electrically connected to the lighting circuit which is a drive circuit. It can consider as the drop which makes a request turn on luminescence equipment by the output pulse from a drive circuit. It is switched with the output signal of the gradation control circuit which calculates the gradation signal for making predetermined brightness turn on each luminescence equipment from the data memorized by RAM (Random, Access, Memory) and RAM which make the data inputted memorize temporarily as a drive circuit, and a gradation control circuit, and has the driver which makes each luminescence equipment turn on. A gradation control circuit calculates the lighting time amount of luminescence equipment from the data memorized by RAM, and outputs it as a pulse signal etc. Here, if drive lighting of the luminescence equipment is carried out, in addition to the luminescent color from luminescence equipment, luminescence of a fluorescent material can also be displayed. Next, if luminescence equipment is made to switch off, it can consider as the drop with which the luminescent color of only the fluorescent material which has afterglow nature is emitting light. A color tone is also changeable by choosing each luminescence wavelength. Therefore, it can consider as the display which attracts attention also in a low power, night, etc.

[0044] (Field-like luminescence light source) Drawing 5 is the example which constituted the field-like luminescence light source using the luminescence equipment of the invention in this application. The dispersion sheet 506 on the coating section or a light guide plate is made to contain a fluorescent material in the case of the field-like luminescence light source. Or it can also consider as the luminescence equipment which was made to carry out spreading etc. to the dispersion sheet 506, formed in the shape of [501] a sheet, and omitted the mold member with binder resin. Specifically, the LED chip 502 is fixed in the metal substrate 503 of the crevice configuration in which the insulating layer and the conductive pattern were formed. After taking an electric flow with an LED chip and the conductive pattern on a substrate, you make it filled up on the substrate 503 into which mixed stirring of the fluorescent material was carried out with the epoxy resin, and the LED chip 502 was loaded, and luminescence equipment is made to form. In this way, the formed luminescence equipment is fixed to the end face of the acrylic light guide plate 504 with an epoxy resin etc. On one principal plane of a light guide plate 504, the reflective member 507 of the shape of a film which the white dispersion agent contained for luminescence unevenness prevention is arranged. Similarly the reflective member 505 is formed also on the end face by which the whole rear-face side surface or luminescence equipment of a light guide plate are not arranged, and luminescence **** is raised. It can consider as the field-like luminescence light source which can obtain brightness sufficient as a back light of LCD by this.

[0045] When using as a liquid crystal display, the polarizing plate arranged through the liquid crystal equipment poured in between the glass substrates with which the translucency conductivity pattern was formed on the principal plane of a light guide plate 504 can be made to constitute. Furthermore, when using it as a portable equipment etc., luminescence equipment, liquid crystal equipment, other operation means, etc. are connected to a cell power source. Moreover, it can have a comparison means in comparison with the set point which the value detected while having a detection means to detect the accumulation-of-electricity residue of a cell power source, ROM (Read On Memory), etc. were made to memorize, and a means to stop the power supplied to luminescence equipment when it makes it judge that it is made to compare and there are few accumulation-of-electricity residues than a request value. Other electrical circuits can be made to drive, making the life of a cell power source prolong by using an LED chip as an astigmatism LGT, or it will reduce the power supplied to an LED chip, if residues, such as a cell power source, become below constant value by this. Moreover, since the solution layer screen changes the luminescent color while being able to emit light efficiently with an afterglow nature fluorescent material, it can also recognize that there are few cell power sources. In this case, as for a fluorescent material, it is desirable to prepare on the shape of a dispersion sheet and the base of a light guide plate.

[0046] When using as a liquid crystal display, since outpatient department light is irradiated by the afterglow nature fluorescent material through a polarizing plate etc., excitation of the light from the outside may be 50% or less. Therefore, depending on outpatient department light, an internal afterglow nature fluorescent material is hard to be excited. Light can be made to shape[of a field]-emit efficiently by making an afterglow nature fluorescent substance emit light by the light emitting device. That is, the invention in this application can be taken as low power and the luminescence equipment which can emit light in high brightness. Although the example of the invention in this application is explained hereafter, it cannot be overemphasized that the invention in this application is not what is limited only to a concrete example.

[0047]

[Example] (Example 1) The GaInN semi-conductor whose main luminescence peak is 410nm as a light emitting device was used. the sapphire substrate top which made the LED chip wash -- TMG (trimethylgallium) gas, TMI (trimethyl in JUMU) gas, nitrogen gas, and dopant gas -- carrier gas -- a sink and MOCVD -- it was made to form by making a gallium nitride system compound semiconductor form by law The gallium nitride semi-conductor which has n mold conductivity, and the gallium nitride semi-conductor which has p mold conductivity were formed, and pn junction was made to form by changing SiH4 and Cp2Mg as dopant gas. (In addition, a buffer layer is made to form on a sapphire substrate, and annealing of the p type semiconductor has been carried out above 400 degrees C after membrane formation.)

[0048] After exposing pn each semi-conductor front face by etching, each electrode was made to form by the sputtering method, respectively. In this way, after lengthening a scribe line, external force was made to divide the done semi-conductor wafer, and the LED chip was made to form as a light emitting device.

[0049] Die bonding of the LED chip was carried out with the epoxy resin on the mounting lead which has a cup at the tip of the copper leadframe which carried out silver plating. Wire bonding of each electrode of an LED chip, a mounting lead, and the inner lead was carried out by the gold streak, respectively, and the electric flow was taken.
[0050] on the other hand — a fluorescent material — as a raw material -- SrCO3 -- 0.015 mols and Dy203 are put into 0.0075 mols, 0.0015 mols and H3BO3 are put [0.988 mols and Eu 2O3] into a 0.024-mol ceramic pot for Tm203, 0.952 mols and aluminum 2O3 are fully mixed with a ball mill, and a mixed raw material (henceforth raw material student powder) is obtained. Next, raw material student powder was put into the alumina crucible, in the muffle furnace of reducing atmosphere, it calcinated at 1400 degrees C for 5 hours, and the fluorescent material burned product was obtained. Next, the burned product was ground and through and O (Sr0.952Eu0.03Dy0.015Tm0.003)-(aluminum 0.988B0.012) 2O3 fluorescent material with a mean particle diameter of 17 micrometers were obtained for the screen.
[0051] O (Sr0.952Eu0.03Dy0.015Tm0.003) and (aluminum 0.988B0.012) the 2O3 fluorescent-material 70 weight section, and the epoxy resin 120 weight section which were formed were often mixed, and it considered as the slurry. This slurry was made to pour in into the cup on the mounting lead with which the LED chip has been arranged. The resin which the afterglow nature fluorescent material contained was stiffened in 130-degree-C 1 hour after impregnation. In this way, the coating section which the afterglow nature fluorescent material with a thickness of 150micro contained was formed on the LED chip. In addition, the afterglow nature fluorescent material is gradually made [many] toward the LED chip at the coating section. Then, the translucency epoxy resin was made to form as a mold member in order to protect an LED chip and an afterglow nature fluorescent material from external force, moisture, dust, etc. further. The mold member inserted the leadframe by which the coating section of an afterglow nature fluorescent material was formed into the shuttering of a shell mold, and was made to harden it after mixing translucency EPOSHIKI resin in 150-degree-C 5 hours.
[0052] In this way, ** which the light emitting diode which has the obtained afterglow nature is saved [**] in a dark place where outdoor daylight is intercepted for 3 hours or more, and carries out continuation lighting for 5 minutes. The luminescent color of light blue green was obtained during lighting. Moreover, luminescence **** was 7.82 lm/w. The light was made to put out after carrying out continuation lighting of the light emitting diode for 5 minutes. The luminescent color of blue green was after putting out lights. The afterglow brightness 10 minutes after putting out lights was 42 1 mcd/m2. Light emitting diode was hardly fallen, when the afterglow brightness same after continuation 1000-hour lighting was measured.
[0053] (Example 1 of a comparison) Formation and a weatherability trial of light emitting diode were performed like the example 1 except having made the fluorescent material into O (Sr0.952Eu0.03Dy0.015Tm0.003)-(aluminum 0.988B0.012) 2O3 to ZnS:Cu. Immediately after energization, the formed light emitting diode had low brightness, although it was sure of luminescence of a Green blue system like the example 1. The light was made to put out after carrying out continuation lighting of the light emitting diode for 5 minutes. The luminescent color of blue green was after putting out lights. The afterglow brightness 10 minutes after putting out lights was 38 mcd/m2. Afterglow nature was undetectable when the afterglow brightness same after continuation 1000-hour lighting was measured for light emitting diode. As a result of analyzing a light emitting diode, the ZnS:Cu fluorescent material on an LED chip had deteriorated.
[0054] (Example 2) The light emitting diode of the invention in this application was used for the LED drop like drawing 4 (A). On the glass epoxy resin substrate in which the copper pattern was made to form, the light emitting diode made to form like an example 1 was arranged in 256 arrow-head configurations except having set the fluorescent material to O-1.75(Sr0.255Eu0.03Dy0.015Zr0.700) (aluminum 0.950B0.050) 2O3. A substrate and light emitting diode soldered using automatic pewter mounting equipment. Next, it was made to arrange and fix to the interior of the case formed with phenol resin. You made it filled up with some of cases, light emitting diodes, and substrates except for the point of light emitting diode by the silicone rubber colored black by the pigment. Then, silicone rubber was stiffened in ordinary temperature and 72 hours, and the LED drop was made to form. This LED drop and a driving means with a clock circuit were connected electrically, and the LED display equipment was constituted. It checked that repeated putting out lights for lighting 1 minute for 2 minutes, an LED drop was made to drive, and it could drive as a low power display.
[0055]
[Effect of the Invention] By considering as the configuration using the light emitting device of a nitride system compound semiconductor, and 2OO-n(M1-p-qEupQq) (aluminum1-mBm) 3 fluorescent material, also in the use at the time of quantity brightness, luminous efficiency is high for a long time, and the fall of luminescence **** or afterglow nature can consider as very little luminescence equipment etc. also in high brightness and prolonged use. Moreover, it is at the lighting and putting-out-lights time, and changing the luminescent color to arbitration can also be used as possible low power luminescence equipment.
[0056] Moreover, since the fall of luminescence **** or afterglow nature can distribute the luminescence unevenness of the LED chip itself with a fluorescent material also in high brightness and prolonged use more in addition to the ability to consider as very few light emitting diodes, the invention in this application can be used as the light emitting diode which has uniform luminescence.
[0057] By considering as the configuration of claim 3 of the invention in this application, a luminescence wavelength component can be increased or it can also consider as the luminescence equipment which can choose the various luminescent color.
[0058]
[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is the typical sectional view of luminescence equipment.
[Drawing 2] Drawing 2 is the typical sectional view of other luminescence equipments.
[Drawing 3] Drawing 3 is drawing having shown an example of the emission spectrum of the invention in this application.
[Drawing 4] Drawing 4 (A), (B), and (C) are the typical sectional views which used the luminescence equipment of the invention in this application for the display, respectively.
[Drawing 5] Drawing 5 is the mimetic diagram using luminescence equipment of an LED display equipment.
[Description of Notations]
101, 401, 501 ... The coating section which the fluorescent material contained
102, 202, 402, 502 ... LED chip
103, 403, 203 ... Conductive wire
104 404 ... Mold member
105 ... Mounting lead
106 ... Inner lead
201 ... Mold member which the fluorescent material contained
204 ... Case

205 ... Electrode prepared in the case
405 ... Electrode connected with the exterior
503 ... Metal substrate
504 ... Light guide plate
505 507 ... Reflective member
506 ... Dispersion sheet

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（Ａ）　(11)特許出願公開番号

特開平10－112557

(43)公開日　平成10年(1998)４月28日

(51)Int.Cl.[6]	識別記号	ＦＩ	
Ｈ０１Ｌ　33/00		Ｈ０１Ｌ　33/00	Ｎ
			Ｃ
Ｃ０９Ｋ　11/64	ＣＰＭ	Ｃ０９Ｋ　11/64	ＣＰＭ
Ｇ０９Ｆ　9/33		Ｇ０９Ｆ　9/33	Ｅ

審査請求　未請求　請求項の数３　ＯＬ　（全 10 頁）

(21)出願番号　特願平8－266450

(22)出願日　平成８年(1996)10月８日

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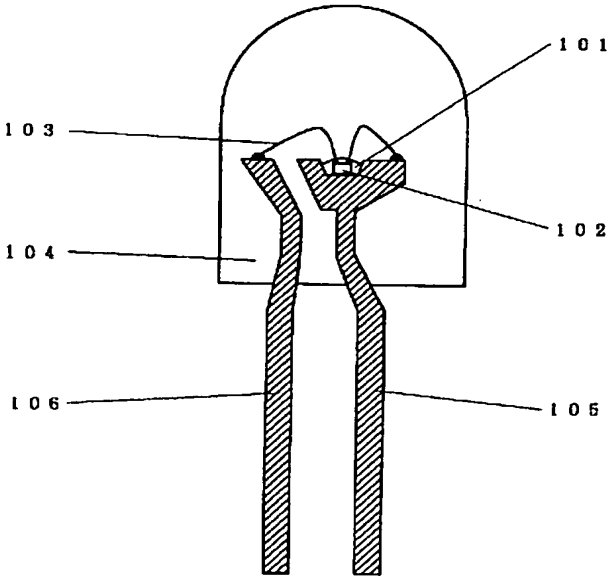
(54)【発明の名称】　発光装置及びそれを用いた表示装置

(57)【要約】

【課題】本願発明は、ＬＥＤチップからの発光の少なくとも一部を変換して発光させる蛍光物質を有し使用環境によらず高輝度、高効率且つ残光性を有する発光装置及びそれを用いた表示装置に関する。

【解決手段】本願発明は、発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光する蛍光物質と、を有する発光装置であって、前記ＬＥＤチップの主発光ピークが３６０ｎｍから５３０ｎｍ内であると共に、前記蛍光物質が２価のユーロピウムで付活され化学組成式が、$(M_{1-p-q}\ Eu_pQ_q)O \cdot n(Al_{1-r}B_r)_2O_3$の発光装置である。但し、組成式中のMは２価金属であり、Qは共付活剤である。



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【特許請求の範囲】

【請求項１】発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光する蛍光物質と、を有する発光装置であって、

前記ＬＥＤチップの主発光ピークが３６０ｎｍから５３０ｎｍ内であると共に、前記蛍光物質が２価のユーロピウムで付活され化学組成式が、$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-m}B_m)_2O_3$であることを特徴とする発光装置。

但し、　０．０００１≦ｐ≦０．５、

０．０００１≦ｑ≦０．５、

０．５≦ｎ≦１０、

０≦ｍ≦０．５、

０．０００２≦ｐ＋ｑ≦０．７５、

組成式中のＭはＭｇ、Ｃａ、Ｓｒ、Ｂａ、及びＺｎからなる２価金属の群より選ばれた少なくとも１種であり、Ｑは共付活剤でありＭｎ、Ｚｒ、Ｎｂ、Ｐｒ、Ｎｄ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｅｒ、Ｔｍ、Ｙｂ、及びＬｕからなる群より選ばれた少なくとも１種である。

【請求項２】マウント・リードのカップ内に配置させたＬＥＤチップと、該ＬＥＤチップと導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、ＬＥＤチップ、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材と、を有する発光ダイオードであって、

前記ＬＥＤチップが窒化ガリウム系化合物半導体であり、且つ前記コーティング部材が２価のユーロピウムで付活され化学組成式が$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-m}B_m)_2O_3$である蛍光物質を含有する透光性樹脂であることを特徴とする発光ダイオード。

但し、　０．０００１≦ｐ≦０．５、

０．０００１≦ｑ≦０．５、

０．５≦ｎ≦１０、

０≦ｍ≦０．５、

０．０００２≦ｐ＋ｑ≦０．７５、

組成式中のＭはＭｇ、Ｃａ、Ｓｒ、Ｂａ、及びＺｎからなる２価金属の群より選ばれた少なくとも１種であり、Ｑは共付活剤でありＭｎ、Ｚｒ、Ｎｂ、Ｐｒ、Ｎｄ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｅｒ、Ｔｍ、Ｙｂ、及びＬｕからなる群より選ばれた少なくとも１種である。

【請求項３】請求項１記載の発光装置を２以上配置した表示器と、該表示器と電気的に接続させた駆動回路と、を有する表示装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本願発明は、バックライト光源、ＬＥＤ表示器、照光式スイッチ及び各種インジケータなどに利用される発光装置に係わり、特に発光素子である

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ＬＥＤチップからの発光の少なくとも一部を変換して発光させる蛍光物質を有し使用環境によらず高輝度、高効率且つ残光性を有する発光装置及びそれを用いた表示装置に関する。

【０００２】

【従来技術】今日、トランシーバー、カメラ、ポケベル、ポータブルラジオ、ビデオデッキやノート型パソコンなどの携帯用電子機器の発達に伴い操作性や視認性向上のために種々の表示装置が設けられている。この表示の一つに液晶装置を利用したものがあり、暗所においても使用できるようバックライトが設けられてある。このようなバックライトは、携帯用電子機器用のバックライトはその消費電力を低下させればさせるほど使用時間などが増えるなどのメリットがあるため、特に低消費電力且つ高輝度に発光することが求められる。このような、バックライト光源の一つにＬＥＤチップからの光源を面状などに発光させることによって高輝度に発光させるものがある。ＬＥＤチップは、小型で効率が良く鮮やかな色の発光をする。また、半導体素子であるため球切れなどの心配がない。初期駆動特性が優れ、振動やON／OFF点灯の繰り返しに強いという特徴を利用したバックライト光源などとすることができる。

【０００３】一方、消防法施行令と全国各都市の火災防止条例などで、劇場、旅館など人の多く集まる場所に誘導灯の設置が義務づけられている。地震、火災などの災害やその他の突発事故により、常用の電源が断たれた場合、自動的に予備電源に切り替わり２０分以上の点灯が必要とされる。このような誘導灯にも高輝度低消費電力であるＬＥＤチップの特性を生かした表示器とすることもできる。

【０００４】しかしながら、ＬＥＤチップを用いて形成させたバックライトなどは半導体発光素子であり、低消費電力とはいえ電池電力を消費する。そのため電池電源の蓄電量が少ない場合において、より長く駆動させるためには大きな負荷となる場合がある。また、災害時に表示器の予備電源が破壊され、あるいは給電回路が破線などすると消灯してしまう場合もある。したがって、電力が少ない場合や給電回路などが停止した場合においても、十分な明るさを表示できる表示器が求められている。

【０００５】

【発明が解決する課題】このような要請に沿う表示装置として、発光ダイオードと、それによって励起される蛍光物質とを有する表示装置が考えられる。

【０００６】しかしながら、ＬＥＤチップは半導体の組成や構造などによって種々の発光波長を有するものがある。同様に、ＬＥＤチップによって励起される蛍光物質も、蛍光染料、蛍光顔料さらには有機、無機化合物や残光性を有するものなど様々なものが挙げられる。

【０００７】また、ＬＥＤチップ周辺に近接して蛍光物

質を配置する場合は、太陽光よりも約３０倍から４０倍、場合によってはそれ以上にも及ぶ強照射強度の光線にさらされる。特に、発光素子であるＬＥＤチップを高エネルギーバンドギャップを有する半導体を用い蛍光物質の変換効率向上や蛍光物質の使用量を減らした場合においては、ＬＥＤチップから発光した主発光が可視光域にあるといっても光エネルギーが必然的に高くなる。また、紫外線領域を発光する場合もあり、発光強度を更に高め長期に渡って使用すると、蛍光物質自体が劣化しやすい。同様にＬＥＤチップの近傍に設けられた蛍光物質は、ＬＥＤチップの昇温や外部環境からの加熱など高温にもさらされる。さらに、発光装置の１種である発光ダイオードは一般的に樹脂モールドに被覆されてはいるものの外部環境からの水分の進入などを完全に防ぐことや製造時に付着した水分を完全に除去することはできない。蛍光物質によっては、このような水分が発光素子からの高エネルギー光や熱によって蛍光物質の劣化を促進する場合もある。また、蛍光物質が劣化すると蛍光物質が黒ずみ光の外部取り出し効率が低下するものや著しく残光性が短くなる場合がある。更には、残光性を示さなくなる場合もある。したがって、本願発明は上記課題を解決し、より高輝度、長時間の使用環境下においても発光光率の低下が極めて少なく残光性を有する発光装置を提供することを目的とする。

【０００８】

【課題を解決するための手段】本願発明は、発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光する蛍光物質と、を有する発光装置であって、前記ＬＥＤチップの主発光ピークが３６０ｎｍから５３０ｎｍ内であると共に、前記蛍光物質が２価のユーロピウムで付活され化学組成式が、$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-m}B_m)_2O_3$である発光装置である。（但し、０．０００１≦ｐ≦０．５、０．０００１≦ｑ≦０．５、０．５≦ｎ≦１０、０≦ｍ≦０．５、０．０００２≦ｐ＋ｑ≦０．７５、組成式中のＭはＭｇ、Ｃａ、Ｓｒ、Ｂａ、及びＺｎからなる２価金属の群より選ばれた少なくとも１種であり、Ｑは共付活剤でありＭｎ、Ｚｒ、Ｎｂ、Ｐｒ、Ｎｄ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｅｒ、Ｔｍ、Ｙｂ、及びＬｕからなる群より選ばれた少なくとも１種である。）

【０００９】また、マウント・リードのカップ内に配置させたＬＥＤチップと、該ＬＥＤチップと導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、ＬＥＤチップ、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材と、を有する発光ダイオードであって、前記ＬＥＤチップが窒化ガリウム系化合物半導体であり、且つ前記コーティング部材が２価のユーロピウムで付活され化学組成式が$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-m}B_m)_2O_3$である蛍光物質を含有する透光性樹脂である発光ダイオードである。（但し、０．０００１≦ｐ≦０．５、０．０００１≦ｑ≦０．５、０．５≦ｎ≦１０、０≦ｍ≦０．５、０．０００２≦ｐ＋ｑ≦０．７５、組成式中のＭはＭｇ、Ｃａ、Ｓｒ、Ｂａ、及びＺｎからなる２価金属の群より選ばれた少なくとも１種であり、Ｑは共付活剤でありＭｎ、Ｚｒ、Ｎｂ、Ｐｒ、Ｎｄ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｅｒ、Ｔｍ、Ｙｂ、及びＬｕからなる群より選ばれた少なくとも１種である。）

【００１０】さらに、上述の発光装置を２以上に配置した表示器と、該表示器と電気的に接続させた駆動回路と、を有する表示装置である。

【００１１】

【発明の実施の形態】本願発明者は、種々の実験の結果、光エネルギーが比較的高いＬＥＤチップからの発光の少なくとも一部を蛍光物質によって波長変換させる発光装置において、特定の半導体及び蛍光物質を選択することにより高輝度、且つ長時間の使用時における光効率や残光性の低下を防止できることを見出し本願発明を成すに至った。

【００１２】即ち、発光装置に用いられる蛍光物質としては、

１．耐光性に優れていることが要求される。特に、半導体発光素子などの微小領域から強放射されるために太陽光の約３０倍から４０倍にもおよぶ強照射にも十分耐える必要がある。２．発光素子近傍に配置されるため温度特性が良好であること。３．発光装置の利用環境に応じて耐候性があること４．発光装置の光、熱などによっても残光性が低下しないことなどの特徴を有することが求められる。

【００１３】これらの条件を満たすものとして本願発明は、発光素子の発光層に高エネルギーバンドギャップを有する窒化ガリウム系化合物半導体素子を、蛍光物質として$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-m}B_m)_2O_3$を用いる。これにより発光素子から放出された可視光域における高エネルギー光を長時間近傍で高輝度に照射した場合であっても発光輝度や残光性の低下が極めて少ない発光装置とすることができるものである。

【００１４】具体的な発光装置の一例として、チップタイプＬＥＤを図２に示す。チップタイプＬＥＤの筐体２０４内に窒化ガリウム系半導体を用いたＬＥＤチップ２０２をエポキシ樹脂などを用いて固定させてある。導電性ワイヤー２０３として金線をＬＥＤチップ２０２の各電極と筐体に設けられた各電極２０５とにそれぞれ電気的に接続させてある。$(Sr_{0.932}Eu_{0.03}Dy_{0.015}Tm_{0.003})O\cdot(Al_{0.988}B_{0.012})_2O_3$蛍光物質をエポキシ樹脂中に混合分散させたものをＬＥＤチップ、導電性ワイヤーなどを外部応力などから保護するモールド部材２０１として均一に硬化形成させる。このような発光装

置に電力を供給させることによってＬＥＤチップ２０２を発光させる。ＬＥＤチップ２０２からの発光と、その発光によって励起された蛍光物質からの発光との混色光が発光される。ＬＥＤチップを消灯後には蛍光物質からの残光のみによって発光可能な発光装置とすることができる。以下、本願発明の構成部材について詳述する。

【００１５】（蛍光物質）本願発明に用いられる蛍光物質としては、半導体発光層から発光された電磁波により励起されて発光する蛍光物質をいう。具体的な蛍光物質としては、$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-r}B_r)_2O_3$である。使用形態としては、種々のものが挙げられる。具体的には、蛍光物質のバルク層内などにＬＥＤチップを閉じこめ蛍光物質層にＬＥＤチップからの光が透過する開口部を１乃至２以上有する構成の発光装置としても良い。また、蛍光物質の粉体をＬＥＤチップを被覆する樹脂や硝子中に含有させＬＥＤチップからの光が透過する程度に薄く形成させても良い。さらには、複数の発光ダイオードを配置させた発光ダイオード間の周辺部材中に混合させても良い。蛍光物質の粒径、蛍光物質と樹脂などとの比率や塗布、充填量を種々調整すること及び発光素子の発光波長を選択することにより種々の色調や残光性を選択することができる。

【００１６】さらに、蛍光物質の含有分布は、混色性や耐久性などにも影響する。すなわち、蛍光物質が含有されたコーティング部やモールド部材などの表面側からＬＥＤチップに向かって蛍光物質の分布濃度が高い場合は、外部環境からの水分などの影響をより受けにくく水分による劣化を抑制しやすい。他方、蛍光物質の含有分布をＬＥＤチップからモールド部材表面側に向かって分布濃度が高くなると外部環境からの水分の影響を受けやすいがＬＥＤチップからの発熱、照射強度などの影響がより少なく蛍光物質の劣化を抑制することができる。このような、蛍光物質の分布は、蛍光物質を含有する部材、形成温度、粘度や蛍光物質の形状、粒度分布などを調整させることによって種々形成させることができる。したがって、使用条件などにより蛍光物質の分布濃度を、種々選択することができる。

【００１７】本願発明に利用される蛍光物質は、ＬＥＤチップと接する或いは近接して配置された場合においても十分な耐光性有する。また、ＬＥＤチップからの放熱が大きい場合は、ｎが１．５から３が特に好ましい。本願発明の残光性蛍光物質に導入する付活剤及び共付活剤は、蛍光色及び残光輝度に大きく影響する。したがって、用途に応じて、それぞれ次に示すような範囲に調整することができる。

【００１８】即ち、付活剤のＥｕの濃度ｐについては、蛍光物質１モルに対し、母体のＳｒを０．０００１モル以上、０．５モル以下置換する範囲に調整することが望ましい。これは０．０００１モルより少ないと光吸収が悪くなり、その結果残光輝度が低下する傾向にあるからである。逆に、０．５モルよりも多くなると、濃度消光を起こし残光輝度が低下する傾向にある。ｐの範囲が、０．００１≦ｐ≦０．０６であることにより、より残光輝度が高くすることができる。

【００１９】共付活剤を導入することによりＥｕの発光は残光性を示すようになる。共付活剤としてＭｎ、Ｚｒ、Ｎｂ、Ｐｒ、Ｎｄ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｅｒ、Ｔｍ、Ｙｂ、及びＬｕからなる群より選ばれた少くなくとも一種が有効である。

【００２０】Ｄｙは蛍光物質の母体である２価金属Ｍが、特にＳｒの場合に残光性向上に効果的であり、Ｄｙ濃度ｑの濃度範囲は０．０００５以上、０．０３以下の範囲が好ましい。同様に、Ｎｄは蛍光物質の母体である２価金属Ｍが、特にＣａの場合に残光輝度向上に特に効果があり、Ｎｄ濃度ｑの範囲は０．０００５以上、０．０３以下の範囲が好ましい。これら共付活剤Ｄｙ、Ｎｄに、他の第２に共付活剤を付活することにより相乗効果を発揮することができる。

【００２１】具体的には、第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＭｎ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００５以上、０．０２以下の範囲である。また、第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＴｍ濃度ｑの好ましい範囲は０．０００３以上、０．０２以下で、更に好ましいのは０．０００４以上、０．０１以下の範囲である。同様に、第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＬｕ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００４以上、０．０４以下の範囲である。第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＮｂ濃度ｑの好ましい範囲は０．０００１以上、０．０８以下で、更に好ましいのは０．０００３以上、０．０４以下の範囲である。第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＹｂ濃度ｑの好ましい範囲は０．０００２以上、０．０４以下で、更に好ましいのは０．０００３以上、０．０１以下の範囲である。第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＺｒ濃度ｑの好ましい範囲は０．００２以上、０．７０以下である。第一の共付活剤としてＤｙを選択する場合、第二の共付活剤のＥｒ濃度ｑの好ましい範囲は０．０００１以上、０．０３以下である。更に好ましいのは０．０００５以上、０．０２以下の範囲である。第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＰｒ濃度ｑの好ましい範囲は０．０００１以上、０．０４以下である。更に好ましいのは０．０００５以上、０．０３以下の範囲である。

【００２２】第一の共付活剤としてＮｄを導入する場合、第２の共付活剤のＴｍ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００５以上、０．０２以下の範囲である。第一の共付

活剤としてＮｄを導入する場合、第２の共付活剤のＰｒ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００５以上、０．０２以下の範囲である。第一の共付活剤としてＮｄを以下導入する場合、第２の共付活剤のＨｏ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００５以上、０．０２以下の範囲である。さらに又、第一の共付活剤としてＮｄを以下導入する場合、第２の共付活剤のＤｙ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００５以上、０．０２以下の範囲である。

【００２３】残光性蛍光物質の母体組成について、アルミニウムの一部をホウ素で置換することもできる。この場合、残光特性をさらに大きく改善させることもできる。したがって、本願発明に用いられる蛍光物質にはホウ素がアルミニウムの総モル数の０１モルから０．５モル置換する範囲が好ましく、より好ましくは、０．００５モルから０．２５モルになる範囲であり、最も好ましいのは、０．０５モル付近である。ホウ素を導入するには、アルミニウムをそれに見合う量だけ差し引いて仕込むことが好ましい。

【００２４】本願発明に用いられる残光性蛍光物質は、原料として例えばＳｒＯ、ＭｇＯ、Al_2O_3、Eu_2O_3のような金属酸化物、或いは$CaCO_3$、$SrCO_3$、$BaCO_3$のような高温で焼成することで容易に酸化物になるような化合物を選択することが好ましい。このような化合物として炭酸塩の他には硝酸塩、シュウ酸塩、水酸化物などがある。また、ホウ素化合物としてはホウ酸あるいはアルカリ土類のホウ酸塩が使用でき、特に、ホウ酸が好ましい。原料の純度は残光輝度に大きく影響し、９９．９％以上であることが好ましく、９９．９９％以上であることがさらに好ましい。これらを混合した原料を、還元雰囲気下１２００℃以上１６００℃以下の温度範囲で焼成し、焼成品を粉砕、篩することで蛍光物質を得ることができる。尚、原料の混合比率は、目的の組成を得る為の理論量を混合することで決定できる。

【００２５】本願発明に用いられる蛍光物質は基本的に付活剤の２価のＥｕによる強い発光を呈するが、２価のＥｕは可視光から紫外域の広範囲に吸収がある。従って、窒化ガリウム系化合物半導体を用いても十分に高効率発光が可能である。また、共付活剤として、Ｍｎ、Ｚｒ、Ｎｂ、Ｐｒ、Ｎｄ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｅｒ、Ｔｍ、Ｙｂ、及びＬｕからなる群より選ばれた少なくとも１種を蛍光物質の母体にドープさせることで残光現象が現れる。

【００２６】残光性蛍光物質においてホウ素を含有させるとアルミネートの結晶性を良好にし、発光中心と捕獲中心を安定化させることで残光時間、残光輝度をさらに改善させることもできる。また、ホウ素は同時にフラックスとして働き蛍光物質の結晶成長を促進する効果をも有する。

【００２７】２価金属、付活剤、共付活剤の酸化物の総モル数とアルミナ及びホウ酸の総モル数がほぼ１：１すなわちｎ＝１である場合、Ｘ線回折により解析した結果、結晶構造は$SrAl_2O_4$型の単斜晶系となり、波長５２０ｎｍにピークのある緑色発光を示す。また、２価金属、付活剤、共付活剤の酸化物の総モル数とアルミナ及びホウ酸の総モル数を１：２すなわちｎ＝２に仕込み焼成した場合、ホウ素の置換が１モル％程度の低濃度では、仕込み組成から生成すべき$SrAl_4O_7$の構造を示すが、ホウ素がこれよりも高濃度では、$Sr_4Al_{14}O_{25}$と$SrAl_{12}O_{19}$の混合物となる。すなわち、ホウ素を含有することにより、結晶構造が変化し、残光性を向上させることもできる。同様に、ｎ＝１．７５の時、$Sr_4Al_{14}O_{25}$となり、耐熱性などをより向上させることもできる。このような組成は、使用目的、ＬＥＤチップからの発光スペクトルや蛍光物質の励起スペクトルを考慮して選択させることが好ましい。

【００２８】即ち、母体組成を特定範囲に調整することにより、発光色は青色、青緑色、緑色と多様に変化させることができる。また、母体組成へのホウ素含有により、結晶構造の安定化、粒子成長を促進でき、その結果として残光の高輝度化が図れる。さらに、第一の共付活剤と第二の共付活剤の組み合わせにより、残光輝度をさらに高輝度化でき、特にＺｒを第二の共付活剤に選択した場合、発光色調も変化させることができる。

【００２９】本願発明の発光装置において、蛍光物質は２種類以上の$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-a}B_a)_2O_3$蛍光物質を混合させてもよい。MやQの元素や含有量が異なる２種類以上の$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-a}B_a)_2O_3$蛍光物質を混合させて発光波長成分を増やすこともできる。これにより、種々の発光色が選択できる発光装置とすることもできる。また、それぞれ異なる樹脂に混合させた多層膜とさせ、半導体発光素子によって励起させることもできる。

【００３０】（ＬＥＤチップ１０２、２０２、４０２、５０２）本願発明に用いられるＬＥＤチップとは、$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-a}B_a)_2O_3$蛍光物質を効率良く励起できる窒化物系化合物半導体が挙げられる。発光素子であるＬＥＤチップは、ＭＯＣＶＤ法等により基板上に一般式$In_aAl_bGa_{1-a-b}N$（但し、０≦ａ、０≦ｂ、ａ＋ｂ＜１）等の窒化物系化合物半導体を発光層として形成させる。半導体の構造としては、ＭＩＳ接合、ＰＩＮ接合やＰＮ接合などを有するホモ構造、ヘテロ構造あるいはダブルヘテロ構成のものが挙げられる。半導体層の材料やその混晶度によって発光波長を種々選択することができる。また、半導体活性層を量子効果が生ずる薄膜に形成させた単一量子井戸構造や多重量子井戸構造とすることもできる。

【００３１】窒化ガリウム系化合物半導体を使用した場

合、半導体基板にはサファイヤ、スピネル、ＳｉＣ、Ｓｉ、ＺｎＯ等の材料が用いられる。結晶性の良い窒化ガリウムを形成させるためにはサファイヤ基板を用いることが好ましい。このサファイヤ基板上にＧａＮ、ＡｌＮ等のバッファー層を形成しその上にＰＮ接合を有する窒化ガリウム系半導体を形成させる。窒化ガリウム系半導体は、不純物をドープしない状態でＮ型導電性を示す。発光効率を向上させるなど所望のＮ型窒化ガリウム半導体を形成させる場合は、Ｎ型ドーパントとしてＳｉ、Ｇｅ、Ｓｅ、Ｔｅ、Ｃ等を適宜導入することが好ましい。一方、Ｐ型窒化ガリウム半導体を形成させる場合は、Ｐ型ドーパンドであるＺｎ、Ｍｇ、Ｂｅ、Ｃａ、Ｓｒ、Ｂａ等をドープさせる。窒化ガリウム系化合物半導体は、Ｐ型ドーパントをドープしただけではＰ型化しにくいためＰ型ドーパント導入後に、炉による加熱、低速電子線照射やプラズマ照射等によりアニールすることでＰ型化させることが好ましい。エッチングなどによりＰ型半導体及びＮ型半導体の露出面を形成させた後、半導体層上にスパッタリング法や真空蒸着法などを用いて所望の形状の各電極を形成させる。

【００３２】次に、形成された半導体ウエハー等をダイヤモンド製の刃先を有するブレードが回転するダイシングソーにより直接フルカットするか、又は刃先幅よりも広い幅の溝を切り込んだ後（ハーフカット）、外力によって半導体ウエハーを割る。あるいは、先端のダイヤモンド針が往復直線運動するスクライバーにより半導体ウエハーに極めて細いスクライブライン（経線）を例えば碁盤目状に引いた後、外力によってウエハーを割り半導体ウエハーからチップ状にカットする。このようにして窒化ガリウム系化合物半導体であるＬＥＤチップを形成させることができる。

【００３３】本願発明の発光装置において効率よく発光及び残光させる場合は、蛍光物質との励起波長等を考慮して発光素子の発光波長は３６０ｎｍ以上５３０ｎｍ以下が好ましく、３８０ｎｍ以上４９０ｎｍ以下がより好ましい。また、樹脂で形成させたモールド部材やコーティング材の劣化やＬＥＤチップ及び蛍光物質の混色を考慮して、発光装置の特性をより向上させるためには、４００ｎｍ以上４７５ｎｍ以下がさらに好ましい。本願発明の残光性を有する発光装置の発光スペクトルを図３に示す。４１０ｎｍ付近にピークを持つ発光がＬＥＤチップからの発光であり、５２０ｎｍ付近にピークを持つ発光がＬＥＤチップによって励起された蛍光物質の発光である。なお、４００ｎｍ未満の発光波長は、紫外線域を含むため蛍光物質からの発光のみの単色性を有することとなる。

【００３４】（導電性ワイヤー１０３、２０３、４０３）導電性ワイヤー１０３、２０３、４０３としては、ＬＥＤチップ１０２、２０２、５０２の電極とのオーミック性、機械的接続性、電気伝導性及び熱伝導性がよいものが求められる。熱伝導度としては０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましく、より好ましくは０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。また、作業性などを考慮して導電性ワイヤーの直径は、好ましくは、Φ１０μｍ以上、Φ４５μｍ以下である。このような導電性ワイヤーとして具体的には、金、銅、白金、アルミニウム等の金属及びそれらの合金を用いた導電性ワイヤーが挙げられる。このような導電性ワイヤーは、各ＬＥＤチップの電極と、インナー・リード及びマウント・リードなどと、をワイヤーボンディング機器によって容易に接続させることができる。

【００３５】（マウント・リード１０５）マウント・リード１０５としては、ＬＥＤチップ１０２を配置させるものであり、ダイボンドダーなどで積載するのに十分な大きさがあれば良い。また、ＬＥＤチップを複数設置しマウント・リードをＬＥＤチップの共通電極として利用する場合においては、十分な電気伝導性とボンディングワイヤー等との接続性が求められる。また、マウント・リード上のカップ内にＬＥＤチップを配置すると共に蛍光物質を内部に充填させる場合は、近接して配置させた別の発光ダイオードからの光により疑似点灯することを防止することができる。

【００３６】ＬＥＤチップ１０２とマウント・リード１０５のカップとの接着は熱硬化性樹脂などによって行うことができる。具体的には、エポキシ樹脂、アクリル樹脂やイミド樹脂などが挙げられる。また、フェースダウンＬＥＤチップなどによりマウント・リードと接着させると共に電気的に接続させるためにはＡｇペースト、カーボンペースト、ＩＴＯペースト、金属バンプ等を用いることができる。さらに、発光ダイオードの光利用効率を向上させるためにＬＥＤチップが配置されるマウント・リードの表面を鏡面状とし、表面に反射機能を持たせても良い。この場合の表面粗さは、０．１Ｓ以上０．８Ｓ以下が好ましい。また、マウント・リードの具体的な電気抵抗としては３００μΩ－ｃｍ以下が好ましく、より好ましくは、３μΩ－ｃｍ以下である。また、マウント・リード上に複数のＬＥＤチップを積置する場合は、ＬＥＤチップからの発熱量が多くなるため熱伝導度がよいことが求められる。具体的には、０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましくより好ましくは０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅、メタライズパターン付きセラミック等が挙げられる。

【００３７】（インナー・リード１０６）インナー・リード１０６としては、マウント・リード１０５上に配置されたＬＥＤチップ１０２と接続された導電性ワイヤー１０３との接続を図るものである。マウント・リード上に複数のＬＥＤチップを設けた場合は、各導電性ワイヤー同士が接触しないよう配置できる構成とする必要がある。具体的には、マウント・リードから離れるに従っ

て、インナー・リードのワイヤーボンディングさせる端面の面積を大きくすることなどによってマウント・リードからより離れたインナー・リードと接続させる導電性ワイヤーの接触を防ぐことができる。導電性ワイヤーとの接続端面の粗さは、密着性を考慮して１．６Ｓ以上１０Ｓ以下が好ましい。インナー・リードの先端部を種々の形状に形成させるためには、あらかじめリードフレームの形状を型枠で決めて打ち抜き形成させてもよく、或いは全てのインナー・リードを形成させた後にインナー・リード上部の一部を削ることによって形成させても良い。さらには、インナー・リードを打ち抜き形成後、端面方向から加圧することにより所望の端面の面積と端面高さを同時に形成させることもできる。

【００３８】インナー・リードは、導電性ワイヤーであるボンディングワイヤー等との接続性及び電気伝導性が良いことが求められる。具体的な電気抵抗としては、３００μΩ－ｃｍ以下が好ましく、より好ましくは３μΩ－ｃｍ以下である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅及び銅、金、銀をメッキしたアルミニウム、鉄、銅等が挙げられる。

【００３９】（コーティング部１０１、５０１）本願発明に用いられるコーティング部１０１、５０１とは、モールド部材１０４とは別にマウント・リードのカップに設けられるものでありＬＥＤチップの発光を変換する残光性蛍光物質が含有されるものである。コーティング部の具体的材料としては、エポキシ樹脂、ユリア樹脂、シリコーンなどの耐候性に優れた透明樹脂や硝子などが好適に用いられる。また、蛍光物質と共に着色顔料、着色染料や拡散剤を含有させても良い。着色顔料や着色染料を用いることによって、色味を調整させることもできる。また、拡散剤を含有させることによってより指向角を増やすこともできる。具体的な拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。

【００４０】（モールド部材１０４、４０４）モールド部材１０４は、発光ダイオードの使用用途に応じてＬＥＤチップ１０２、導電性ワイヤー１０３、蛍光物質が含有されたコーティング部１０１などを外部から保護するために設けることができる。モールド部材は、硝子や樹脂を用いて形成させることができる。また、蛍光物質を含有させることによって視野角を増やすことができるが、モールド部材に拡散剤を含有させることによってＬＥＤチップ１０２からの指向性を緩和させ視野角をさらに増やすことができる。更にまた、モールド部材１０４を所望の形状にすることによってＬＥＤチップからの発光を集束させたり拡散させたりするレンズ効果を持たせることができる。従って、モールド部材１０４は複数積層した構造でもよい。具体的には、凸レンズ形状、凹レンズ形状さらには、発光観測面側から見て楕円形状やそれらを複数組み合わせたものが挙げられる。

【００４１】モールド部材１０４の具体的材料としては、主としてエポキシ樹脂、ユリア樹脂、シリコーンなどの耐候性に優れた透明樹脂や硝子などが好適に用いられる。また、拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。さらに、拡散剤に加えてモールド部材中にも蛍光物質を含有させることもできる。したがって、蛍光物質はモールド部材中に含有させてもそれ以外のコーティング部などに含有させて用いてもよい。また、コーティング部を蛍光物質が含有された樹脂、モールド部材を硝子などとした異なる部材を用いて形成させても良い。この場合、生産性良くより水分などの影響が少ない発光ダイオードとすることができる。また、屈折率を考慮してモールド部材とコーティング部とを同じ部材を用いて形成させても良い。

【００４２】（表示装置）本願発明の発光装置をＬＥＤ表示器に利用した場合の一例として、標識、矢印形状など所望の形状に発光装置を配置させたＬＥＤ表示器の概略断面構成を図４に示す。図４（Ａ）は、ＬＥＤチップ４０２の発光面上モールド部材中に均等に残光性蛍光物質が混合された発光装置を並べたものであり、図４（Ｂ）は、コーティング部材上にモールド部材４０４を形成させた発光ダイオードとして形成させた発光装置を並べたものである。また、図４（Ｃ）は、ＬＥＤチップ４０２が発光する面の周囲方向のみに長残光性蛍光物質含有部材４０１を配置させた発光装置を示す。いずれの発光装置も同様の駆動回路に接続させた表示装置とさせることができる。

【００４３】ＬＥＤ表示器は、駆動回路である点灯回路などと電気的に接続させる。駆動回路からの出力パルスによって発光装置を所望に点灯させる表示器とすることができる。駆動回路としては、入力されるデータを一時的に記憶させるＲＡＭ（Ｒａｎｄｏｍ、Ａｃｃｅｓｓ、Ｍｅｍｏｒｙ）と、ＲＡＭに記憶されるデータから各発光装置を所定の明るさに点灯させるための階調信号を演算する階調制御回路と、階調制御回路の出力信号でスイッチングされて、各発光装置を点灯させるドライバーと、を備える。階調制御回路は、ＲＡＭに記憶されるデータから発光装置の点灯時間を演算してパルス信号などとして出力する。ここで、発光装置を駆動点灯させると、発光装置からの発光色に加えて蛍光物質の発光をも表示させることができる。次に、発光装置を消灯させると、残光性を有する蛍光物質のみの発光色が発光している表示器とさせることができる。それぞれの発光波長を選択することで色調を変えることもできる。したがって、低消費電力且つ夜間などにおいても注意を引く表示装置などとすることができる。

【００４４】（面状発光光源）図５は本願発明の発光装置を利用した面状発光光源を構成した例である。面状発光光源の場合、蛍光物質をコーティング部や導光板上の

散乱シート５０６に含有させる。或いはバインダー樹脂と共に散乱シート５０６に塗布などさせシート状５０１に形成しモールド部材を省略した発光装置とすることもできる。具体的には、絶縁層及び導電性パターンが形成された凹部形状の金属基板５０３内にＬＥＤチップ５０２を固定する。ＬＥＤチップと基板上の導電性パターンとの電気的導通を取った後、蛍光物質をエポキシ樹脂と混合撹拌しＬＥＤチップ５０２が積載された基板５０３上に充填させ発光装置を形成させる。こうして形成された発光装置は、アクリル性導光板５０４の端面にエポキシ樹脂などで固定される。導光板５０４の一方の主面上には、発光むら防止のため白色散乱剤が含有されたフィルム状の反射部材５０７を配置させてある。同様に、導光板の裏面側全面や発光装置が配置されていない端面上にも反射部材５０５を設け発光光率を向上させてある。これにより、ＬＣＤのバックライトとして十分な明るさを得られる面状発光光源とすることができる。

【００４５】液晶表示装置として利用する場合は、導光板５０４の主面上に透光性導電性パターンが形成された硝子基板間に注入された液晶装置を介して配された偏光板により構成させることができる。さらに、携帯用機器などとして使用する場合は、発光装置、液晶装置と他の演算手段などとを電池電源に接続させる。また、電池電源の蓄電残量を検出する検出手段を備えると共に検出された値とＲＯＭ（Ｒｅａｄ Ｏｎ Ｍｅｍｏｒｙ）などに記憶させた設定値と比較する比較手段、比較させ所望値よりも蓄電残量が少ないと判断させた場合には発光装置に供給する電力を停止する手段と、を備えることができる。これにより電池電源などの残量が一定値以下になるとＬＥＤチップに供給する電力を低下させる或いはＬＥＤチップを非点灯とさせることによって、電池電源の延命させつつ他の電気回路を駆動させることができる。また、液層表示面は残光性蛍光物質によって効率よく発光可能であると共に発光色を変化するため電池電源が少ないことを認識することもできる。この場合、蛍光物質は散乱シート状或いは導光板の底面上に設けることが好ましい。

【００４６】液晶表示装置として利用する場合は、外来光が偏光板などを介して残光性蛍光物質に照射されるため外部からの光の励起が５０％以下となる場合がある。したがって、外来光によっては内部の残光性蛍光物質が励起されにくい。残光性蛍光体を発光素子によって発光させることによって効率よく面状発光させることができる。すなわち、本願発明は低電力、且つ高輝度に発光可能な発光装置とさせることができるものである。以下、本願発明の実施例について説明するが、本願発明は具体的実施例のみに限定されるものではないことは言うまでもない。

【００４７】

【実施例】

（実施例１）発光素子として主発光ピークが４１０ｎｍのＧａＩｎＮ半導体を用いた。ＬＥＤチップは、洗浄させたサファイヤ基板上にＴＭＧ（トリメチルガリウム）ガス、ＴＭＩ（トリメチルインジュム）ガス、窒素ガス及びドーパントガスをキャリアガスと共に流し、ＭＯＣＶＤ法で窒化ガリウム系化合物半導体を成膜させることにより形成させた。ドーパントガスとしてＳｉＨ₄とＣｐ₂Ｍｇと、を切り替えることによってＮ型導電性を有する窒化ガリウム半導体とＰ型導電性を有する窒化ガリウム半導体を形成しＰＮ接合を形成させた。（なお、サファイヤ基板上には、バッファ層を形成させ、Ｐ型半導体は成膜後４００℃以上でアニールさせてある。）

【００４８】エッチングによりＰＮ各半導体表面を露出させた後、スパッタリング法により各電極をそれぞれ形成させた。こうして出来上がった半導体ウエハーをスクライブラインを引いた後、外力により分割させ発光素子としてＬＥＤチップを形成させた。

【００４９】銀メッキした銅製リードフレームの先端にカップを有するマウント・リード上にＬＥＤチップをエポキシ樹脂でダイボンディングした。ＬＥＤチップの各電極とマウント・リード及びインナー・リードと、をそれぞれ金線でワイヤーボンディングし電気的導通を取った。

【００５０】一方、蛍光物質は、原料として、$SrCO_3$を０．９５２モル、Al_2O_3を０．９８８モル、Eu_2O_3を０．０１５モル、Dy_2O_3を０．００７５モル、Tm_2O_3を０．００１５モル及びH_3BO_3を０．０２４モルセラミックポットに入れ、ボールミルにより十分に混合し混合原料（以下原料生粉という）を得る。次に、原料生粉をアルミナルツボに入れ、還元雰囲気のマッフル炉中で、１４００℃で５時間焼成し蛍光物質焼成品を得た。次に焼成品を粉砕し、篩を通し、平均粒径１７μｍの$(Sr_{0.952}Eu_{0.03}Dy_{0.015}Tm_{0.003})O\cdot(Al_{0.988}B_{0.012})_2O_3$蛍光物質を得た。

【００５１】形成された$(Sr_{0.952}Eu_{0.03}Dy_{0.015}Tm_{0.003})O\cdot(Al_{0.988}B_{0.012})_2O_3$蛍光物質７０重量部、エポキシ樹脂１２０重量部をよく混合してスリラーとさせた。このスリラーをＬＥＤチップが配置されたマウント・リード上のカップ内に注入させた。注入後、残光性蛍光物質が含有された樹脂を１３０℃１時間で硬化させた。こうしてＬＥＤチップ上に厚さ１５０μの残光性蛍光物質が含有されたコーティング部が形成された。なお、コーティング部には、ＬＥＤチップに向かって残光性蛍光物質が徐々に多くしてある。その後、さらにＬＥＤチップや残光性蛍光物質を外部応力、水分及び塵芥などから保護する目的でモールド部材として透光性エポキシ樹脂を形成させた。モールド部材は、砲弾型の型枠の中に残光性蛍光物質のコーティング部が形成されたリードフレームを挿入し透光性エポシキ樹脂を混入後、１５０℃５時間にて硬化させた。

【００５２】こうして得られた残光性を有する発光ダイオードを暗所に３時間以上外光を遮断した状態で保存し、５分間連続点灯させるた。点灯中は淡いブルーグリーンの発光色が得られた。また、発光光率は７．８２ｌｍ／ｗであった。発光ダイオードを５分間連続点灯させた後消灯させた。消灯後においてもブルーグリーンの発光色があった。消灯１０分後における残光輝度は、４２１ｍｃｄ／m^2であった。発光ダイオードを連続１００００時間点灯後に同様の残光輝度を測定したところほとんど低下していなかった。

【００５３】（比較例１）蛍光物質を（$Sr_{0.952}$　$Eu_{0.03}$　$Dy_{0.015}$　$Tm_{0.003}$）O･（$Al_{0.988}$　$B_{0.012}$）$_2O_3$からＺｎＳ：Ｃｕとした以外は、実施例１と同様にして発光ダイオードの形成及び耐候試験を行った。形成された発光ダイオードは通電直後、実施例１と同様グリーンブルー系の発光が確信されたが輝度が低かった。発光ダイオードを５分間連続点灯させた後消灯させた。消灯後においてもブルーグリーンの発光色があった。消灯１０分後における残光輝度は、３８ｍｃｄ／m^2であった。発光ダイオードを連続１０００時間点灯後に同様の残光輝度を測定したところ残光性を検出することができなかった。発光ダイオードを解析した結果、ＬＥＤチップ上のＺｎＳ：Ｃｕ蛍光物質が劣化していた。

【００５４】（実施例２）本願発明の発光ダイオードを図４（Ａ）の如きＬＥＤ表示器に利用した。蛍光物質を（$Sr_{0.255}$　$Eu_{0.03}$　$Dy_{0.015}$　$Zr_{0.700}$）O･１．７５（$Al_{0.950}$　$B_{0.050}$）$_2O_3$とした以外は実施例１と同様にして形成させた発光ダイオードを銅パターンを形成させた硝子エポキシ樹脂基板上に、矢印形状に２５６個配置させた。基板と発光ダイオードとは自動ハンダ実装装置を用いてハンダ付けを行った。次にフェノール樹脂によって形成された筐体内部に配置し固定させた。発光ダイオードの先端部を除いて筐体、発光ダイオード、基板の一部をピグメントにより黒色に着色したシリコンゴムによって充填させた。その後、常温、７２時間でシリコンゴムを硬化させＬＥＤ表示器を形成させた。このＬＥＤ表示器と、クロック回路を持った駆動手段と、を電気的に接続させてＬＥＤ表示装置を構成した。ＬＥＤ表示器を２分点灯１分消灯を繰り返して駆動させ低電力表示装置として駆動できることを確認した。

【００５５】

【発明の効果】窒化物系化合物半導体の発光素子と、（M_{1-p-q}　Eu_pQ_q）O・n（Al_{1-r}　B_r）$_2O_3$蛍光物質と、を利用した本願発明の請求項１の構成とすることにより長時間高輝度時の使用においても発光効率が高く、高輝度、長時間の使用においても発光光率や残光性の低下が極めて少ない発光装置などとすることができる。また、点灯時と消灯時で発光色を任意に変化させることも可能な低電力発光装置として使用することもできる。

【００５６】また、本願発明の請求項２の構成とすることにより高輝度、長時間の使用においても発光光率や残光性の低下が極めて少ない発光ダイオードとすることができることに加えて、ＬＥＤチップ自体の発光むらを蛍光物質により分散することができるためより均一な発光を有する発光ダイオードとすることができる。

【００５７】本願発明の請求項３の構成とすることにより、屋外など直射日光にさらされるような場所に用いられるＬＥＤ表示器においても残光性を有し且つ、視認角度によって色むらの少ない低電力ＬＥＤ表示装置とすることができる。

【００５８】

【図面の簡単な説明】

【図１】図１は、本願発明の発光装置の模式的断面図である。

【図２】図２は、本願発明の他の発光装置の模式的断面図である。

【図３】図３は、本願発明の発光スペクトルの一例を示した図である。

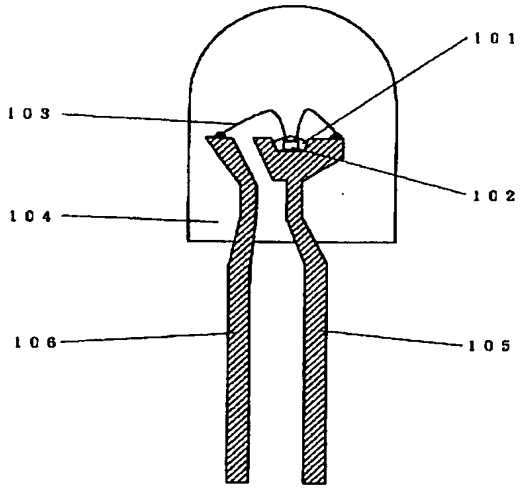
【図４】図４（Ａ）、（Ｂ）、（Ｃ）は、それぞれ本願発明の発光装置を表示装置に利用した模式的断面図である。

【図５】図５は、本願発明の発光装置を利用したＬＥＤ表示装置の模式図である。

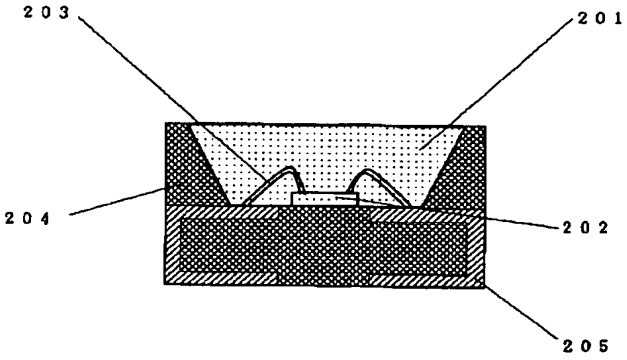
【符号の説明】

１０１、４０１、５０１・・・蛍光物質が含有されたコーティング部
１０２、２０２、４０２、５０２・・・ＬＥＤチップ
１０３、４０３、２０３・・・導電性ワイヤー
１０４、４０４・・・モールド部材
１０５・・・マウント・リード
１０６・・・インナー・リード
２０１・・・蛍光物質が含有されたモールド部材
２０４・・・筐体
２０５・・・筐体に設けられた電極
４０５・・・外部と接続される電極
５０３・・・金属製基板
５０４・・・導光板
５０５、５０７・・・反射部材
５０６・・・散乱シート

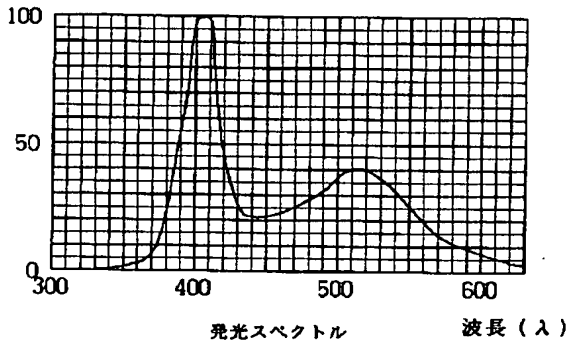
【図１】


101
103
102
104
106
105

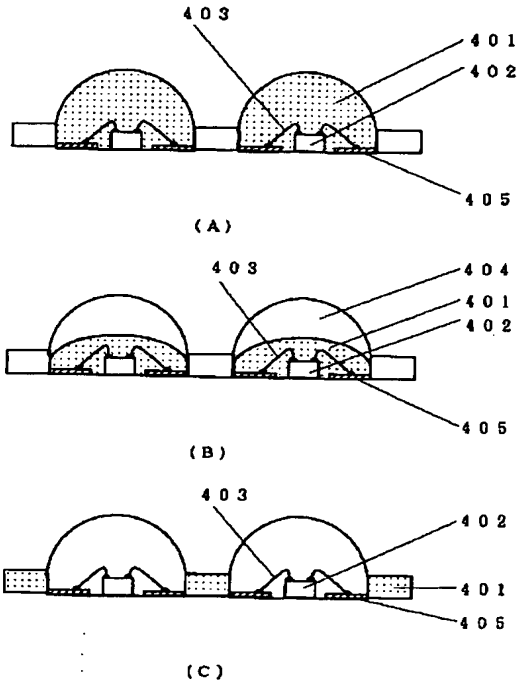
【図２】


203
201
204
202
205

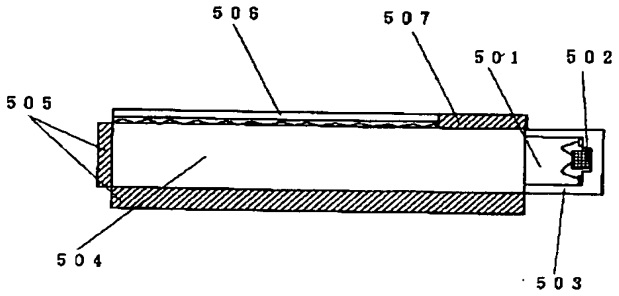
【図３】


100
50
0
300
400
500
600
発光スペクトル
波長（λ）

【図４】


403
401
402
405
(A)
403
404
401
402
405
(B)
403
402
401
405
(C)

【図５】


506
507
501
502
505
504
503

【公報種別】特許法第１７条の２の規定による補正の掲載
【部門区分】第７部門第２区分
【発行日】平成１３年１０月１２日（２００１．１０．１２）

【公開番号】特開平１０－１１２５５７
【公開日】平成１０年４月２８日（１９９８．４．２８）
【年通号数】公開特許公報１０－１１２６
【出願番号】特願平８－２６６４５０
【国際特許分類第７版】
H01L 33/00

C09K 11/64 CPM
G09F 9/33
【ＦＩ】
H01L 33/00 N
C
C09K 11/64 CPM
G09F 9/33 E

【手続補正書】
【提出日】平成１３年１月１５日（２００１．１．１５）
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】全文
【補正方法】変更
【補正内容】
【書類名】　明細書
【発明の名称】　発光装置
【特許請求の範囲】
【請求項１】　発光層が窒化ガリウム系化合物半導体であるＬＥＤチップ（４０２）と、該ＬＥＤチップを被覆するモールド部材と、該ＬＥＤチップが被覆されたモールド部材の周囲方向に配置された周辺部材（４０１）とを有する発光装置であって、
前記周辺部材（４０１）は前記発光層からの発光により励起されて発光する蛍光物質を具備してなることを特徴とする発光装置。
【請求項２】　前記蛍光物質は２価のユーロピウムで付活され化学組成式が、$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-m}B_m)_2O_3$である請求項１記載の発光装置。
但し、　０．０００１≦ｐ≦０．５、
０．０００１≦ｑ≦０．５、
０．５≦ｎ≦１０、
０≦ｍ≦０．５、
０．０００２≦ｐ＋ｑ≦０．７５、
組成式中のMはＭｇ、Ｃａ、Ｓｒ、Ｂａ、及びＺｎからなる２価金属の群より選ばれた少なくとも１種であり、Ｑは共付活剤でありＭｎ、Ｚｒ、Ｎｂ、Ｐｒ、Ｎｄ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｅｒ、Ｔｍ、Ｙｂ、及びＬｕからなる群より選ばれた少なくとも１種である。
【請求項３】　前記蛍光物質は異なる２種類以上が混合されてなる請求項１乃至請求項２記載の発光装置。
【請求項４】　前記周辺部材（４０１）はモールド部材でＬＥＤチップが被覆された複数の発光ダイオード間に配置されてなる請求項１乃至３記載の発光装置。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本願発明は、バックライト光源、ＬＥＤ表示器、照光式スイッチ及び各種インジケータなどに利用される発光装置に係わり、特に発光素子であるＬＥＤチップからの発光の少なくとも一部を変換して発光させる蛍光物質を有し使用環境によらず高輝度、高効率且つ残光性を有する発光装置及びそれを用いた表示装置に関する。
【０００２】
【従来技術】今日、トランシーバー、カメラ、ポケベル、ポータブルラジオ、ビデオデッキやノート型パソコンなどの携帯用電子機器の発達に伴い操作性や視認性向上のために種々の表示装置が設けられている。この表示の一つに液晶装置を利用したものがあり、暗所においても使用できるようバックライトが設けられてある。このようなバックライトは、携帯用電子機器用のバックライトはその消費電力を低下させればさせるほど使用時間などが増えるなどのメリットがあるため、特に低消費電力且つ高輝度に発光することが求められる。このような、バックライト光源の一つにＬＥＤチップからの光源を面状などに発光させることによって高輝度に発光させるものがある。ＬＥＤチップは、小型で効率が良く鮮やかな色の発光をする。また、半導体素子であるため球切れな

どの心配がない。初期駆動特性が優れ、振動やON／OFF点灯の繰り返しに強いという特徴を利用したバックライト光源などとすることができる。

【０００３】一方、消防法施行令と全国各都市の火災防止条例などで、劇場、旅館など人の多く集まる場所に誘導灯の設置が義務づけられている。地震、火災などの災害やその他の突発事故により、常用の電源が断たれた場合、自動的に予備電源に切り替わり２０分以上の点灯が必要とされる。このような誘導灯にも高輝度低消費電力であるＬＥＤチップの特性を生かした表示器とすることもできる。

【０００４】しかしながら、ＬＥＤチップを用いて形成させたバックライトなどは半導体発光素子であり、低消費電力とはいえ電池電力を消費する。そのため電池電源の蓄電量が少ない場合において、より長く駆動させるためには大きな負荷となる場合がある。また、災害時に表示器の予備電源が破壊され、あるいは給電回路が破線などすると消灯してしまう場合もある。したがって、電力が少ない場合や給電回路などが停止した場合においても、十分な明るさを表示できる表示器が求められている。

【０００５】

【発明が解決する課題】このような要請に沿う表示装置として、発光ダイオードと、それによって励起される蛍光物質とを有する表示装置が考えられる。

【０００６】しかしながら、ＬＥＤチップは半導体の組成や構造などによって種々の発光波長を有するものがある。同様に、ＬＥＤチップによって励起される蛍光物質も、蛍光染料、蛍光顔料さらには有機、無機化合物や残光性を有するものなど様々なものが挙げられる。

【０００７】また、ＬＥＤチップ周辺に近接して蛍光物質を配置する場合は、太陽光よりも約３０倍から４０倍、場合によってはそれ以上にも及ぶ強照射強度の光線にさらされる。特に、発光素子であるＬＥＤチップに高エネルギーバンドギャップを有する半導体を用い蛍光物質の変換効率向上や蛍光物質の使用量を減らした場合においては、ＬＥＤチップから発光した主発光が可視光域にあるといっても光エネルギーが必然的に高くなる。また、紫外線領域を発光する場合もあり、発光強度を更に高め長期に渡って使用すると、蛍光物質自体が劣化しやすい。同様にＬＥＤチップの近傍に設けられた蛍光物質は、ＬＥＤチップの昇温や外部環境からの加熱など高温にもさらされる。さらに、発光装置の１種である発光ダイオードは一般的に樹脂モールドに被覆されてはいるものの外部環境からの水分の進入などを完全に防ぐことや製造時に付着した水分を完全に除去することはできない。蛍光物質によっては、このような水分が発光素子からの高エネルギー光や熱によって蛍光物質の劣化を促進する場合もある。また、蛍光物質が劣化すると蛍光物質が黒ずみ光の外部取り出し効率が低下するものや著しく残光性が短くなる場合がある。更には、残光性を示さなくなる場合もある。したがって、本願発明は上記課題を解決し、より高輝度、長時間の使用環境下においても発光光率の低下が極めて少なく残光性を有する発光装置を提供することを目的とする。

【０００８】

【課題を解決するための手段】本願発明は発光層が窒化ガリウム系化合物半導体であるＬＥＤチップ（４０２）と、ＬＥＤチップを被覆するモールド部材と、ＬＥＤチップが被覆されたモールド部材の周囲方向に配置された周辺部材（４０１）とを有する発光装置において周辺部材（４０１）が発光層からの発光により励起されて発光する蛍光物質を具備してなる発光装置である。

【０００９】　また、請求項２記載の発光装置は、蛍光物質が２価のユーロピウムで付活され化学組成式が、$(M_{1-p-q}\ Eu_pQ_q)O\cdot n(Al_{1-m}B_m)_2O_3$である。（但し、０．０００１≦ｐ≦０．５、０．０００１≦ｑ≦０．５、０．５≦ｎ≦１０、０≦ｍ≦０．５、０．０００２≦ｐ＋ｑ≦０．７５、組成式中のＭはＭｇ、Ｃａ、Ｓｒ、Ｂａ、及びＺｎからなる２価金属の群より選ばれた少なくとも１種であり、Ｑは共付活剤でありＭｎ、Ｚｒ、Ｎｂ、Ｐｒ、Ｎｄ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｅｒ、Ｔｍ、Ｙｂ、及びＬｕからなる群より選ばれた少なくとも１種である。）

【００１０】　さらに、請求項３記載の発光装置は蛍光物質が異なる２種類以上が混合されてなるり、請求項４記載の発光装置は周辺部材（４０１）がモールド部材でＬＥＤチップが被覆された複数の発光ダイオード間に配置されてなる。

【００１１】

【発明の実施の形態】本願発明者は、種々の実験の結果、光エネルギーが比較的高いＬＥＤチップからの発光の少なくとも一部を蛍光物質によって波長変換させる発光装置において、特定の半導体及び蛍光物質を選択することにより高輝度、且つ長時間の使用時における光効率や残光性の低下を防止できることを見出し本願発明を成すに至った。

【００１２】即ち、発光装置に用いられる蛍光物質としては、

１．耐光性に優れていることが要求される。特に、半導体発光素子などの微小領域から強放射されるために太陽光の約３０倍から４０倍にもおよぶ強照射にも十分耐える必要がある。２．発光素子近傍に配置されるため温度特性が良好であること。３．発光装置の利用環境に応じて耐候性があること４．発光装置の光、熱などによっても残光性が低下しないことなどの特徴を有することが求められる。

【００１３】これらの条件を満たすものとして本願発明は、発光素子の発光層に高エネルギーバンドギャップを有する窒化ガリウム系化合物半導体素子を、蛍光物質と

して（M_{1-p-q} Eu_pQ_q）O・n（Al_{1-s} B_s）$_2O_3$を用いる。これにより発光素子から放出された可視光域における高エネルギー光を長時間近傍で高輝度に照射した場合であっても発光輝度や残光性の低下が極めて少ない発光装置とすることができるものである。

【００１４】具体的な発光装置の一例として、チップタイプＬＥＤを図２に示す。チップタイプＬＥＤの筐体２０４内に窒化ガリウム系半導体を用いたＬＥＤチップ２０２をエポキシ樹脂などを用いて固定させてある。導電性ワイヤー２０３として金線をＬＥＤチップ２０２の各電極と筐体に設けられた各電極２０５とにそれぞれ電気的に接続させてある。（$Sr_{0.952}$ $Eu_{0.03}$ $Dy_{0.015}$ $Tm_{0.003}$）O・（$Al_{0.988}$ $B_{0.012}$）$_2O_3$蛍光物質をエポキシ樹脂中に混合分散させたものをＬＥＤチップ、導電性ワイヤーなどを外部応力などから保護するモールド部材２０１として均一に硬化形成させる。このような発光装置に電力を供給させることによってＬＥＤチップ２０２を発光させる。ＬＥＤチップ２０２からの発光と、その発光によって励起された蛍光物質からの発光との混色光が発光される。ＬＥＤチップを消灯後には蛍光物質からの残光のみによって発光可能な発光装置とすることができる。以下、本願発明の構成部材について詳述する。

【００１５】（蛍光物質）本願発明に用いられる蛍光物質としては、半導体発光層から発光された電磁波により励起されて発光する蛍光物質をいう。具体的な蛍光物質としては、（M_{1-p-q} Eu_pQ_q）O・n（Al_{1-s} B_s）$_2O_3$である。使用形態としては、種々のものが挙げられる。具体的には、蛍光物質のバルク層内などにＬＥＤチップを閉じこめ蛍光物質層にＬＥＤチップからの光が透過する開口部を１乃至２以上有する構成の発光装置としても良い。また、蛍光物質の粉体をＬＥＤチップを被覆する樹脂や硝子中に含有させＬＥＤチップからの光が透過する程度に薄く形成させても良い。さらには、複数の発光ダイオードを配置させた発光ダイオード間の周辺部材中に混合させても良い。蛍光物質の粒径、蛍光物質と樹脂などとの比率や塗布、充填量を種々調整すること及び発光素子の発光波長を選択することにより種々の色調や残光性を選択することができる。

【００１６】さらに、蛍光物質の含有分布は、混色性や耐久性などにも影響する。すなわち、蛍光物質が含有されたコーティング部やモールド部材などの表面側からＬＥＤチップに向かって蛍光物質の分布濃度が高い場合は、外部環境からの水分などの影響をより受けにくく水分による劣化を抑制しやすい。他方、蛍光物質の含有分布をＬＥＤチップからモールド部材表面側に向かって分布濃度が高くなると外部環境からの水分の影響を受けやすいがＬＥＤチップからの発熱、照射強度などの影響がより少なく蛍光物質の劣化を抑制することができる。このような、蛍光物質の分布は、蛍光物質を含有する部材、形成温度、粘度や蛍光物質の形状、粒度分布などを調整させることによって種々形成させることができる。したがって、使用条件などにより蛍光物質の分布濃度を、種々選択することができる。

【００１７】本願発明に利用される蛍光物質は、ＬＥＤチップと接する或いは近接して配置された場合においても十分な耐光性有する。また、ＬＥＤチップからの放熱が大きい場合は、ｎが１．５から３が特に好ましい。本願発明の残光性蛍光物質に導入する付活剤及び共付活剤は、蛍光色及び残光輝度に大きく影響する。したがって、用途に応じて、それぞれ次に示すような範囲に調整することができる。

【００１８】即ち、付活剤のＥｕの濃度ｐについては、蛍光物質１モルに対し、母体のＳｒを０．０００１モル以上、０．５モル以下置換する範囲に調整することが望ましい。これは０．０００１モルより少ないと光吸収が悪くなり、その結果残光輝度が低下する傾向にあるからである。逆に、０．５モルよりも多くなると、濃度消光を起こし残光輝度が低下する傾向にある。ｐの範囲が、$0.001 \leqq p \leqq 0.06$であることにより、より残光輝度が高くすることができる。

【００１９】共付活剤を導入することによりＥｕの発光は残光性を示すようになる。共付活剤としてＭｎ、Ｚｒ、Ｎｂ、Ｐｒ、Ｎｄ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｅｒ、Ｔｍ、Ｙｂ、及びＬｕからなる群より選ばれた少くなくとも一種が有効である。

【００２０】Ｄｙは蛍光物質の母体である２価金属Ｍが、特にＳｒの場合に残光性向上に効果的であり、Ｄｙ濃度ｑの濃度範囲は０．０００５以上、０．０３以下の範囲が好ましい。同様に、Ｎｄは蛍光物質の母体である２価金属Ｍが、特にＣａの場合に残光輝度向上に特に効果があり、Ｎｄ濃度ｑの範囲は０．０００５以上、０．０３以下の範囲が好ましい。これら共付活剤Ｄｙ、Ｎｄに、他の第２に共付活剤を付活することにより相乗効果を発揮することができる。

【００２１】具体的には、第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＭｎ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００５以上、０．０２以下の範囲である。また、第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＴｍ濃度ｑの好ましい範囲は０．０００３以上、０．０２以下で、更に好ましいのは０．０００４以上、０．０１以下の範囲である。同様に、第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＬｕ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００４以上、０．０４以下の範囲である。第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＮｂ濃度ｑの好ましい範囲は０．０００１以上、０．０８以下で、更に好ましいのは０．０００３以上、０．０４以下の範囲である。第一の共付活剤としてＤｙを選択する場合、第２の共付活剤の

Ｙｂ濃度ｑの好ましい範囲は０．０００２以上、０．０４以下で、更に好ましいのは０．０００３以上、０．０１以下の範囲である。第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＺｒ濃度ｑの好ましい範囲は０．００２以上、０．７０以下である。第一の共付活剤としてＤｙを選択する場合、第二の共付活剤のＥｒ濃度ｑの好ましい範囲は０．０００１以上、０．０３以下である。更に好ましいのは０．０００５以上、０．０２以下の範囲である。第一の共付活剤としてＤｙを選択する場合、第２の共付活剤のＰｒ濃度ｑの好ましい範囲は０．０００１以上、０．０４以下である。更に好ましいのは０．０００５以上、０．０３以下の範囲である。

【００２２】第一の共付活剤としてＮｄを導入する場合、第２の共付活剤のＴｍ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００５以上、０．０２以下の範囲である。第一の共付活剤としてＮｄを導入する場合、第２の共付活剤のＰｒ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００５以上、０．０２以下の範囲である。第一の共付活剤としてＮｄを以下導入する場合、第２の共付活剤のＨｏ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００５以上、０．０２以下の範囲である。さらに又、第一の共付活剤としてＮｄを以下導入する場合、第２の共付活剤のＤｙ濃度ｑの好ましい範囲は０．０００１以上、０．０６以下で、更に好ましいのは０．０００５以上、０．０２以下の範囲である。

【００２３】残光性蛍光物質の母体組成について、アルミニウムの一部をホウ素で置換することもできる。この場合、残光特性をさらに大きく改善させることもできる。したがって、本願発明に用いられる蛍光物質にはホウ素がアルミニウムの総モル数の０１モルから０．５モル置換する範囲が好ましく、より好ましくは、０．００５モルから０．２５モルになる範囲であり、最も好ましいのは、０．０５モル付近である。ホウ素を導入するには、アルミニウムをそれに見合う量だけ差し引いて仕込むことが好ましい。

【００２４】本願発明に用いられる残光性蛍光物質は、原料として例えばＳｒＯ、ＭｇＯ、Al_2O_3、Eu_2O_3のような金属酸化物、或いは$CaCO_3$、$SrCO_3$、$BaCO_3$のような高温で焼成することで容易に酸化物になるような化合物を選択することが好ましい。このような化合物として炭酸塩の他には硝酸塩、シュウ酸塩、水酸化物などがある。また、ホウ素化合物としてはホウ酸あるいはアルカリ土類のホウ酸塩が使用でき、特に、ホウ酸が好ましい。原料の純度は残光輝度に大きく影響し、９９．９％以上であることが好ましく、９９．９９％以上であることがさらに好ましい。これらを混合した原料を、還元雰囲気下１２００℃以上１６００℃以下の温度範囲で焼成し、焼成品を粉砕、篩することで蛍光物質を得ることができる。尚、原料の混合比率は、目的の組成を得る為の理論量を混合することで決定できる。

【００２５】本願発明に用いられる蛍光物質は基本的に付活剤の２価のＥｕによる強い発光を呈するが、２価のＥｕは可視光から紫外域の広範囲に吸収がある。従って、窒化ガリウム系化合物半導体を用いても十分に高効率発光が可能である。また、共付活剤として、Ｍｎ、Ｚｒ、Ｎｂ、Ｐｒ、Ｎｄ、Ｇｄ、Ｔｂ、Ｄｙ、Ｈｏ、Ｅｒ、Ｔｍ、Ｙｂ、及びＬｕからなる群より選ばれた少なくとも１種を蛍光物質の母体にドープさせることで残光現象が現れる。

【００２６】残光性蛍光物質においてホウ素を含有させるとアルミネートの結晶性を良好にし、発光中心と捕獲中心を安定化させることで残光時間、残光輝度をさらに改善させることもできる。また、ホウ素は同時にフラックスとして働き蛍光物質の結晶成長を促進する効果をも有する。

【００２７】２価金属、付活剤、共付活剤の酸化物の総モル数とアルミナ及びホウ酸の総モル数がほぼ１：１すなわちｎ＝１である場合、Ｘ線回折により解析した結果、結晶構造は$SrAl_2O_4$型の単斜晶系となり、波長５２０ｎｍにピークのある緑色発光を示す。また、２価金属、付活剤、共付活剤の酸化物の総モル数とアルミナ及びホウ酸の総モル数を１：２すなわちｎ＝２に仕込み焼成した場合、ホウ素の置換が１モル％程度の低濃度では、仕込み組成から生成すべき$SrAl_4O_7$の構造を示すが、ホウ素がこれよりも高濃度では、$Sr_4Al_{14}O_{25}$と$SrAl_{12}O_{19}$の混合物となる。すなわち、ホウ素を含有することにより、結晶構造が変化し、残光性を向上させることもできる。同様に、ｎ＝１．７５の時、$Sr_4Al_{14}O_{25}$となり、耐熱性などをより向上させることもできる。このような組成は、使用目的、ＬＥＤチップからの発光スペクトルや蛍光物質の励起スペクトルを考慮して選択させることが好ましい。

【００２８】即ち、母体組成を特定範囲に調整することにより、発光色は青色、青緑色、緑色と多様に変化させることができる。また、母体組成へのホウ素含有により、結晶構造の安定化、粒子成長を促進でき、その結果として残光の高輝度化が図れる。さらに、第一の共付活剤と第二の共付活剤の組み合わせにより、残光輝度をさらに高輝度化でき、特にＺｒを第二の共付活剤に選択した場合、発光色調も変化させることができる。

【００２９】本願発明の発光装置において、蛍光物質は２種類以上の$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-a}B_a)_2O_3$蛍光物質を混合させてもよい。MやQの元素や含有量が異なる２種類以上の$(M_{1-p-q}Eu_pQ_q)O\cdot n(Al_{1-a}B_a)_2O_3$蛍光物質を混合させて発光波長成分を増やすこともできる。これにより、種々の発光色が選択できる発光装置とすることもできる。また、それぞれ異なる樹脂に混合させた多層膜とさせ、半導体発

光素子によって励起させることもできる。

【００３０】（ＬＥＤチップ１０２、２０２、４０２、５０２）本願発明に用いられるＬＥＤチップとは、（$M_{1-p-q}Eu_pQ_q$）Ｏ・ｎ（$Al_{1-r}B_r$）$_2O_3$蛍光物質を効率良く励起できる窒化物系化合物半導体が挙げられる。発光素子であるＬＥＤチップは、ＭＯＣＶＤ法等により基板上に一般式$In_aAl_bGa_{1-a-b}N$（但し、０≦ａ、０≦ｂ、ａ＋ｂ＜１）等の窒化物系化合物半導体を発光層として形成させる。半導体の構造としては、ＭＩＳ接合、ＰＩＮ接合やｐｎ接合などを有するホモ構造、ヘテロ構造あるいはダブルヘテロ構成のものが挙げられる。半導体層の材料やその混晶度によって発光波長を種々選択することができる。また、半導体活性層を量子効果が生ずる薄膜に形成させた単一量子井戸構造や多重量子井戸構造とすることもできる。

【００３１】窒化ガリウム系化合物半導体を使用した場合、半導体基板にはサファイヤ、スピネル、ＳｉＣ、Ｓｉ、ＺｎＯ等の材料が用いられる。結晶性の良い窒化ガリウムを形成させるためにはサファイヤ基板を用いることが好ましい。このサファイヤ基板上にＧａＮ、ＡｌＮ等のバッファー層を形成しその上にｐｎ接合を有する窒化ガリウム系半導体を形成させる。窒化ガリウム系半導体は、不純物をドープしない状態でｎ型導電性を示す。発光効率を向上させるなど所望のｎ型窒化ガリウム半導体を形成させる場合は、ｎ型ドーパントとしてＳｉ、Ｇｅ、Ｓｅ、Ｔｅ、Ｃ等を適宜導入することが好ましい。一方、ｐ型窒化ガリウム半導体を形成させる場合は、ｐ型ドーパンドであるＺｎ、Ｍｇ、Ｂｅ、Ｃａ、Ｓｒ、Ｂａ等をドープさせる。窒化ガリウム系化合物半導体は、ｐ型ドーパントをドープしただけではｐ型化しにくいためｐ型ドーパント導入後に、炉による加熱、低速電子線照射やプラズマ照射等によりアニールすることでｐ型化させることが好ましい。エッチングなどによりＰ型半導体及びＮ型半導体の露出面を形成させた後、半導体層上にスパッタリング法や真空蒸着法などを用いて所望の形状の各電極を形成させる。

【００３２】次に、形成された半導体ウエハー等をダイヤモンド製の刃先を有するブレードが回転するダイシングソーにより直接フルカットするか、又は刃先幅よりも広い幅の溝を切り込んだ後（ハーフカット）、外力によって半導体ウエハーを割る。あるいは、先端のダイヤモンド針が往復直線運動するスクライバーにより半導体ウエハーに極めて細いスクライブライン（経線）を例えば碁盤目状に引いた後、外力によってウエハーを割り半導体ウエハーからチップ状にカットする。このようにして窒化ガリウム系化合物半導体であるＬＥＤチップを形成させることができる。

【００３３】本願発明の発光装置において効率よく発光及び残光させる場合は、蛍光物質との励起波長等を考慮して発光素子の発光波長は３６０ｎｍ以上５３０ｎｍ以下が好ましく、３８０ｎｍ以上４９０ｎｍ以下がより好ましい。また、樹脂で形成させたモールド部材やコーティング材の劣化やＬＥＤチップ及び蛍光物質の混色を考慮して、発光装置の特性をより向上させるためには、４００ｎｍ以上４７５ｎｍ以下がさらに好ましい。本願発明の残光性を有する発光装置の発光スペクトルを図３に示す。４１０ｎｍ付近にピークを持つ発光がＬＥＤチップからの発光であり、５２０ｎｍ付近にピークを持つ発光がＬＥＤチップによって励起された蛍光物質の発光である。なお、４００ｎｍ未満の発光波長は、紫外線域を含むため蛍光物質からの発光のみの単色性を有することとなる。

【００３４】（導電性ワイヤー１０３、２０３、４０３）導電性ワイヤー１０３、２０３、４０３としては、ＬＥＤチップ１０２、２０２、５０２の電極とのオーミック性、機械的接続性、電気伝導性及び熱伝導性がよいものが求められる。熱伝導度としては０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましく、より好ましくは０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。また、作業性などを考慮して導電性ワイヤーの直径は、好ましくは、Φ１０μｍ以上、Φ４５μｍ以下である。このような導電性ワイヤーとして具体的には、金、銅、白金、アルミニウム等の金属及びそれらの合金を用いた導電性ワイヤーが挙げられる。このような導電性ワイヤーは、各ＬＥＤチップの電極と、インナー・リード及びマウント・リードなどと、をワイヤーボンディング機器によって容易に接続させることができる。

【００３５】（マウント・リード１０５）マウント・リード１０５としては、ＬＥＤチップ１０２を配置させるものであり、ダイボンドダーなどで積載するのに十分な大きさがあれば良い。また、ＬＥＤチップを複数設置しマウント・リードをＬＥＤチップの共通電極として利用する場合においては、十分な電気伝導性とボンディングワイヤー等との接続性が求められる。また、マウント・リード上のカップ内にＬＥＤチップを配置すると共に蛍光物質を内部に充填させる場合は、近接して配置させた別の発光ダイオードからの光により疑似点灯することを防止することができる。

【００３６】ＬＥＤチップ１０２とマウント・リード１０５のカップとの接着は熱硬化性樹脂などによって行うことができる。具体的には、エポキシ樹脂、アクリル樹脂やイミド樹脂などが挙げられる。また、フェースダウンＬＥＤチップなどによりマウント・リードと接着させると共に電気的に接続させるためにはＡｇペースト、カーボンペースト、ＩＴＯペースト、金属バンプ等を用いることができる。さらに、発光ダイオードの光利用効率を向上させるためにＬＥＤチップが配置されるマウント・リードの表面を鏡面状とし、表面に反射機能を持たせても良い。この場合の表面粗さは、０．１Ｓ以上０．８Ｓ以下が好ましい。また、マウント・リードの具体的な

電気抵抗としては３００μΩ・ｃｍ以下が好ましく、より好ましくは、３μΩ・ｃｍ以下である。また、マウント・リード上に複数のＬＥＤチップを積置する場合は、ＬＥＤチップからの発熱量が多くなるため熱伝導度がよいことが求められる。具体的には、０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましくより好ましくは０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅、メタライズパターン付きセラミック等が挙げられる。

【００３７】（インナー・リード１０６）インナー・リード１０６としては、マウント・リード１０５上に配置されたＬＥＤチップ１０２と接続された導電性ワイヤー１０３との接続を図るものである。マウント・リード上に複数のＬＥＤチップを設けた場合は、各導電性ワイヤー同士が接触しないよう配置できる構成とする必要がある。具体的には、マウント・リードから離れるに従って、インナー・リードのワイヤーボンディングさせる端面の面積を大きくすることなどによってマウント・リードからより離れたインナー・リードと接続させる導電性ワイヤーの接触を防ぐことができる。導電性ワイヤーとの接続端面の粗さは、密着性を考慮して１．６Ｓ以上１０Ｓ以下が好ましい。インナー・リードの先端部を種々の形状に形成させるためには、あらかじめリードフレームの形状を型枠で決めて打ち抜き形成させてもよく、或いは全てのインナー・リードを形成させた後にインナー・リード上部の一部を削ることによって形成させても良い。さらには、インナー・リードを打ち抜き形成後、端面方向から加圧することにより所望の端面の面積と端面高さを同時に形成させることもできる。

【００３８】インナー・リードは、導電性ワイヤーであるボンディングワイヤー等との接続性及び電気伝導性が良いことが求められる。具体的な電気抵抗としては、３００μΩ・ｃｍ以下が好ましく、より好ましくは３μΩ・ｃｍ以下である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅及び銅、金、銀をメッキしたアルミニウム、鉄、銅等が挙げられる。

【００３９】（コーティング部１０１、５０１）本願発明に用いられるコーティング部１０１、５０１とは、モールド部材１０４とは別にマウント・リードのカップに設けられるものでありＬＥＤチップの発光を変換する残光性蛍光物質が含有されるものである。コーティング部の具体的材料としては、エポキシ樹脂、ユリア樹脂、シリコーンなどの耐候性に優れた透明樹脂や硝子などが好適に用いられる。また、蛍光物質と共に着色顔料、着色染料や拡散剤を含有させても良い。着色顔料や着色染料を用いることによって、色味を調整させることもできる。また、拡散剤を含有させることによってより指向角を増やすこともできる。具体的な拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。

【００４０】（モールド部材１０４、４０４）モールド部材１０４は、発光ダイオードの使用用途に応じてＬＥＤチップ１０２、導電性ワイヤー１０３、蛍光物質が含有されたコーティング部１０１などを外部から保護するために設けることができる。モールド部材は、硝子や樹脂を用いて形成させることができる。また、蛍光物質を含有させることによって視野角を増やすことができるが、モールド部材に拡散剤を含有させることによってＬＥＤチップ１０２からの指向性を緩和させ視野角をさらに増やすことができる。更にまた、モールド部材１０４を所望の形状にすることによってＬＥＤチップからの発光を集束させたり拡散させたりするレンズ効果を持たせることができる。従って、モールド部材１０４は複数積層した構造でもよい。具体的には、凸レンズ形状、凹レンズ形状さらには、発光観測面側から見て楕円形状やそれらを複数組み合わせたものが挙げられる。

【００４１】モールド部材１０４の具体的材料としては、主としてエポキシ樹脂、ユリア樹脂、シリコーンなどの耐候性に優れた透明樹脂や硝子などが好適に用いられる。また、拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。さらに、拡散剤に加えてモールド部材中にも蛍光物質を含有させることもできる。したがって、蛍光物質はモールド部材中に含有させてもそれ以外のコーティング部などに含有させて用いてもよい。また、コーティング部を蛍光物質が含有された樹脂、モールド部材を硝子などとした異なる部材を用いて形成させても良い。この場合、生産性良くより水分などの影響が少ない発光ダイオードとすることができる。また、屈折率を考慮してモールド部材とコーティング部とを同じ部材を用いて形成させても良い。

【００４２】（表示装置）本願発明の発光装置をＬＥＤ表示器に利用した場合の一例として、標識、矢印形状など所望の形状に発光装置を配置させたＬＥＤ表示器の概略断面構成を図４に示す。図４（Ａ）は、ＬＥＤチップ４０２の発光面上モールド部材中に均等に残光性蛍光物質が混合された発光装置を並べたものであり、図４（Ｂ）は、コーティング部材上にモールド部材４０４を形成させた発光ダイオードとして形成させた発光装置を並べたものである。また、図４（Ｃ）は、ＬＥＤチップ４０２が発光する面の周囲方向のみに長残光性蛍光物質含有部材４０１を配置させた発光装置を示す。いずれの発光装置も同様の駆動回路に接続させた表示装置とさせることができる。

【００４３】ＬＥＤ表示器は、駆動回路である点灯回路などと電気的に接続させる。駆動回路からの出力パルスによって発光装置を所望に点灯させる表示器とすることができる。駆動回路としては、入力されるデータを一時的に記憶させるＲＡＭ（Ｒａｎｄｏｍ、Ａｃｃｅｓｓ、Ｍｅｍｏｒｙ）と、ＲＡＭに記憶されるデータから各発

光装置を所定の明るさに点灯させるための階調信号を演算する階調制御回路と、階調制御回路の出力信号でスイッチングされて、各発光装置を点灯させるドライバーと、を備える。階調制御回路は、ＲＡＭに記憶されるデータから発光装置の点灯時間を演算してパルス信号などとして出力する。ここで、発光装置を駆動点灯させると、発光装置からの発光色に加えて蛍光物質の発光をも表示させることができる。次に、発光装置を消灯させると、残光性を有する蛍光物質のみの発光色が発光している表示器とさせることができる。それぞれの発光波長を選択することで色調を変えることもできる。したがって、低消費電力且つ夜間などにおいても注意を引く表示装置などとすることができる。

【００４４】（面状発光光源）図５は本願発明の発光装置を利用した面状発光光源を構成した例である。面状発光光源の場合、蛍光物質をコーティング部や導光板上の散乱シート５０６に含有させる。或いはバインダー樹脂と共に散乱シート５０６に塗布などさせシート状５０１に形成しモールド部材を省略した発光装置とすることもできる。具体的には、絶縁層及び導電性パターンが形成された凹部形状の金属基板５０３内にＬＥＤチップ５０２を固定する。ＬＥＤチップと基板上の導電性パターンとの電気的導通を取った後、蛍光物質をエポキシ樹脂と混合撹拌しＬＥＤチップ５０２が積載された基板５０３上に充填させ発光装置を形成させる。こうして形成された発光装置は、アクリル性導光板５０４の端面にエポキシ樹脂などで固定される。導光板５０４の一方の主面上には、発光むら防止のため白色散乱剤が含有されたフィルム状の反射部材５０７を配置させてある。同様に、導光板の裏面側全面や発光装置が配置されていない端面上にも反射部材５０５を設け発光光率を向上させてある。これにより、ＬＣＤのバックライトとして十分な明るさを得られる面状発光光源とすることができる。

【００４５】液晶表示装置として利用する場合は、導光板５０４の主面上に透光性導電性パターンが形成された硝子基板間に注入された液晶装置を介して配された偏光板により構成させることができる。さらに、携帯用機器などとして使用する場合は、発光装置、液晶装置と他の演算手段などとを電池電源に接続させる。また、電池電源の蓄電残量を検出する検出手段を備えると共に検出された値とＲＯＭ（Ｒｅａｄ Ｏｎ Ｍｅｍｏｒｙ）などに記憶させた設定値と比較する比較手段、比較させ所望値よりも蓄電残量が少ないと判断させた場合には発光装置に供給する電力を停止する手段と、を備えることができる。これにより電池電源などの残量が一定値以下になるとＬＥＤチップに供給する電力を低下させる或いはＬＥＤチップを非点灯とさせることによって、電池電源の延命させつつ他の電気回路を駆動させることができる。また、液層表示面は残光性蛍光物質によって効率よく発光可能であると共に発光色を変化するため電池電源が少ないことを認識することもできる。この場合、蛍光物質は散乱シート状或いは導光板の底面上に設けることが好ましい。

【００４６】液晶表示装置として利用する場合は、外来光が偏光板などを介して残光性蛍光物質に照射されるため外部からの光の励起が５０％以下となる場合がある。したがって、外来光によっては内部の残光性蛍光物質が励起されにくい。残光性蛍光体を発光素子によって発光させることによって効率よく面状発光させることができる。すなわち、本願発明は低電力、且つ高輝度に発光可能な発光装置とさせることができるものである。以下、本願発明の実施例について説明するが、本願発明は具体的実施例のみに限定されるものではないことは言うまでもない。

【００４７】

【実施例】（実施例１）発光素子として主発光ピークが４１０ｎｍのＧａＩｎＮ半導体を用いた。ＬＥＤチップは、洗浄させたサファイヤ基板上にＴＭＧ（トリメチルガリウム）ガス、ＴＭＩ（トリメチルインジュム）ガス、窒素ガス及びドーパントガスをキャリアガスと共に流し、ＭＯＣＶＤ法で窒化ガリウム系化合物半導体を成膜させることにより形成させた。ドーパントガスとしてSiH_4とCp_2Mgと、を切り替えることによってｎ型導電性を有する窒化ガリウム半導体とｐ型導電性を有する窒化ガリウム半導体を形成しｐｎ接合を形成させた。（なお、サファイヤ基板上には、バッファ層を形成させ、ｐ型半導体は成膜後４００℃以上でアニールさせてある。）

【００４８】エッチングによりｐｎ各半導体表面を露出させた後、スパッタリング法により各電極をそれぞれ形成させた。こうして出来上がった半導体ウエハーをスクライブラインを引いた後、外力により分割させ発光素子としてＬＥＤチップを形成させた。

【００４９】銀メッキした銅製リードフレームの先端にカップを有するマウント・リード上にＬＥＤチップをエポキシ樹脂でダイボンディングした。ＬＥＤチップの各電極とマウント・リード及びインナー・リードと、をそれぞれ金線でワイヤーボンディングし電気的導通を取った。

【００５０】一方、蛍光物質は、原料として、$SrCO_3$を０．９５２モル、Al_2O_3を０．９８８モル、Eu_2O_3を０．０１５モル、Dy_2O_3を０．００７５モル、Tm_2O_3を０．００１５モル及びH_3BO_3を０．０２４モルセラミックポットに入れ、ボールミルにより十分に混合し混合原料（以下原料生粉という）を得る。次に、原料生粉をアルミナルツボに入れ、還元雰囲気のマッフル炉中で、１４００℃で５時間焼成し蛍光物質焼成品を得た。次に焼成品を粉砕し、篩を通し、平均粒径１７μｍの$(Sr_{0.952}Eu_{0.03}Dy_{0.015}Tm_{0.003})O\cdot(Al_{0.988}B_{0.012})_2O_3$蛍光物質を得た。

【００５１】形成された($Sr_{0.952}Eu_{0.03}Dy_{0.015}Tm_{0.003}$)O･($Al_{0.988}B_{0.012}$)$_2O_3$蛍光物質７０重量部、エポキシ樹脂１２０重量部をよく混合してスラリーとさせた。このスラリーをＬＥＤチップが配置されたマウント・リード上のカップ内に注入させた。注入後、残光性蛍光物質が含有された樹脂を１３０℃１時間で硬化させた。こうしてＬＥＤチップ上に厚さ１５０μの残光性蛍光物質が含有されたコーティング部が形成された。なお、コーティング部には、ＬＥＤチップに向かって残光性蛍光物質が徐々に多くしてある。その後、さらにＬＥＤチップや残光性蛍光物質を外部応力、水分及び塵芥などから保護する目的でモールド部材として透光性エポキシ樹脂を形成させた。モールド部材は、砲弾型の型枠の中に残光性蛍光物質のコーティング部が形成されたリードフレームを挿入し透光性エポシキ樹脂を混入後、１５０℃５時間にて硬化させた。

【００５２】こうして得られた残光性を有する発光ダイオードを暗所に３時間以上外光を遮断した状態で保存し、５分間連続点灯させるた。点灯中は淡いブルーグリーンの発光色が得られた。また、発光光率は７．８２１ｍ／ｗであった。発光ダイオードを５分間連続点灯させた後消灯させた。消灯後においてもブルーグリーンの発光色があった。消灯１０分後における残光輝度は、４２１ｍｃｄ／m^2であった。発光ダイオードを連続１０００時間点灯後に同様の残光輝度を測定したところほとんど低下していなかった。

【００５３】（比較例１）蛍光物質を($Sr_{0.952}Eu_{0.03}Dy_{0.015}Tm_{0.003}$)O･($Al_{0.988}B_{0.012}$)$_2O_3$からＺｎＳ：Ｃｕとした以外は、実施例１と同様にして発光ダイオードの形成及び耐候試験を行った。形成された発光ダイオードは通電直後、実施例１と同様グリーンブルー系の発光が確信されたが輝度が低かった。発光ダイオードを５分間連続点灯させた後消灯させた。消灯後においてもブルーグリーンの発光色があった。消灯１０分後における残光輝度は、３８ｍｃｄ／m^2であった。発光ダイオードを連続１０００時間点灯後に同様の残光輝度を測定したところ残光性を検出することができなかった。発光ダイオードを解析した結果、ＬＥＤチップ上のＺｎＳ：Ｃｕ蛍光物質が劣化していた。

【００５４】（実施例２）本願発明の発光ダイオードを図４（Ａ）の如きＬＥＤ表示器に利用した。蛍光物質を($Sr_{0.255}Eu_{0.03}Dy_{0.015}Zr_{0.700}$)O･1.75($Al_{0.950}B_{0.050}$)$_2O_3$とした以外は実施例１と同様にして形成させた発光ダイオードを銅パターンを形成させた硝子エポキシ樹脂基板上に、矢印形状に２５６個配置させた。基板と発光ダイオードとは自動ハンダ実装装置を用いてハンダ付けを行った。次にフェノール樹脂によって形成された筐体内部に配置し固定させた。発光ダイオードの先端部を除いて筐体、発光ダイオード、基板の一部をピグメントにより黒色に着色したシリコンゴムによって充填させた。その後、常温、７２時間でシリコンゴムを硬化させＬＥＤ表示器を形成させた。このＬＥＤ表示器と、クロック回路を持った駆動手段と、を電気的に接続させてＬＥＤ表示装置を構成した。ＬＥＤ表示器を２分点灯１分消灯を繰り返して駆動させ低電力表示装置として駆動できることを確認した。

【００５５】

【発明の効果】窒化物系化合物半導体の発光素子と、($M_{1-p-q}Eu_pQ_n$)O･n($Al_{1-s}B_s$)$_2O_3$蛍光物質とを利用した構成とすることにより長時間高輝度時の使用においても発光効率が高く、高輝度、長時間の使用においても発光光率や残光性の低下が極めて少ない発光装置などとすることができる。また、点灯時と消灯時で発光色を任意に変化させることも可能な低電力発光装置として使用することもできる。

【００５６】また、本願発明は、より高輝度、長時間の使用においても発光光率や残光性の低下が極めて少ない発光ダイオードとすることができることに加えて、ＬＥＤチップ自体の発光むらを蛍光物質により分散することができるためより均一な発光を有する発光ダイオードとすることができる。

【００５７】本願発明の請求項３の構成とすることにより、発光波長成分を増やしたり、種々の発光色が選択できる発光装置とすることもできる。

【００５８】

【図面の簡単な説明】

【図１】　図１は、発光装置の模式的断面図である。

【図２】　図２は、他の発光装置の模式的断面図である。

【図３】　図３は、本願発明の発光スペクトルの一例を示した図である。

【図４】　図４（Ａ）、（Ｂ）、（Ｃ）は、それぞれ本願発明の発光装置を表示装置に利用した模式的断面図である。

【図５】　図５は、発光装置を利用したＬＥＤ表示装置の模式図である。

【符号の説明】

１０１、４０１、５０１・・・蛍光物質が含有されたコーティング部

１０２、２０２、４０２、５０２・・・ＬＥＤチップ

１０３、４０３、２０３・・・導電性ワイヤー

１０４、４０４・・・モールド部材

１０５・・・マウント・リード

１０６・・・インナー・リード

２０１・・・蛍光物質が含有されたモールド部材

２０４・・・筐体

２０５・・・筐体に設けられた電極

４０５・・・外部と接続される電極

５０３・・・金属製基板

５０４・・・導光板

５０５、５０７・・・反射部材

５０６・・・散乱シート